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It’s Not Just a Sign: Traffic Calming Gives Bump to Safety – A Cost Benefit Analysis ofTraffic Calming in the City of Los Angeles

Author
Patel, Asiya

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It's Not Just a Sign: Traffic Calming Gives Bump to Safety

A Cost Benefit Analysis of Traffic Calming in the City of Los Angeles

Project Lead: Asiya Patel
Faculty Advisor: Michael Manville
Client: Severin Martinez, Los Angeles Department of Transportation

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16. Abstract
The Los Angeles Department of Transportation (LADOT) has implemented traffic calming measures across the city, recognizing that collisions may not be preventable but can be reduced in severity through roadway design. The department has a process whereby residents can apply for speed humps on a quarterly basis, but the program is oversubscribed. There are few studies in LA that address the effectiveness and ability to equitably distribute the benefits of traffic calming. This report is framed by the central question: How effective are the low-cost traffic safety interventions that the City of Los Angeles frequently uses on its residential streets? Interventions covered in this study include speed humps, bike lanes, partial closures and stop signs. I used four metrics to evaluate effectiveness, including traffic speed, traffic count (ADT), collision frequency and collision severity. I conducted paired sample t-tests to compare speed and volume one year before and after measures were introduced. Additionally, I used the Statewide Integrated Traffic Records System (SWITRS) to evaluate collisions. The results of this study show that speed humps are the most cost-effective and proven method of traffic calming included in this analysis. The severity and number of collisions reduced as a result of introducing all measures. Design measures that make a road less viable for thoroughfare like partial closures can reduce cut-through traffic and related collisions. At minimum, LADOT should consider restructuring the petitioning process by lowering the threshold to apply for speed humps and prioritize key places like schools and low-income communities.

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Executive Summary

The City of Los Angeles adopted a Vision Zero policy with the goal of eliminating fatal traffic deaths by 2025, but this vision will be difficult to fully achieve without lowering cut-through traffic in residential neighborhoods. To this end, the Los Angeles Department of Transportation (LADOT) has implemented traffic calming measures throughout the city, recognizing that collisions may not be entirely preventable but can be reduced in likelihood and severity through roadway design. The department has a process whereby residents can apply for speed humps on a quarterly basis but the program is oversubscribed. Traffic calming is highly in demand, however, there are few studies that address this problem in Los Angeles within the past few years. This report is framed by the central question:

How effective are the low-cost traffic safety interventions that the City of Los Angeles frequently uses on its residential streets?

Interventions covered in this study include speed humps, bike lanes, partial closures and stop signs. It is worth noting that stop signs are designed to control traffic rather than slow it down, and that bike lanes are designed to protect bicyclists rather than to calm traffic; however, these measures are commonly included as part of traffic calming programs and are included for comparison. I used four metrics to evaluate the effectiveness of each, including traffic speed, traffic count (ADT), collision frequency and collision severity. I conducted paired sample t-tests for all measures to compare speed and volume one year before and after they were introduced. I also used the Statewide Integrated Traffic Records System (SWITRS) to evaluate collisions one year before and after to address whether measures had any impact on safety. The results of this study show that:

- Speed humps are the most cost-effective and proven method of traffic calming included in this analysis.
- The severity and number of collisions reduced as a result of introducing all measures, including speed humps, road diets/bike lanes, partial closures and stop signs.

- Design measures that make a road less viable for thoroughfare (i.e. partial closures, peak hour turn restrictions) can reduce cut-through traffic volume and related collisions.

What makes speed humps great is not just that they work, but they are also low in cost. This research suggests that the City should invest more in speed humps and remove barriers that prevent placement in communities of need. Few alternatives to the speed hump can be implemented at a large enough scale to cover the thousands of miles of streets in Los Angeles on a cost-limited basis.

At minimum, LADOT should consider restructuring the petitioning process by lowering the threshold to apply for speed humps and have a different process for streets with higher residential density. Secondly, the city should consider replacing or complementing the existing request-based traffic calming with a quantitative prioritization process by identifying key areas like schools and low-income neighborhoods. Third, the traffic calming budget should be increased to allow for more speed humps and other measures to be installed throughout the city. In combination with these efforts, the city can create a user guide in both Spanish and English to enhance accessibility and increase understanding of the local benefits of traffic calming. Altogether, these changes would make traffic calming in Los Angeles more accessible and effective, by expanding its reach and prioritizing measurable safety needs.

Introduction

Quality of life in a city is directly and indirectly related to strategic investment in transportation infrastructure. The built environment shapes our access to opportunity, our levels of physical activity, and how we feel. Not only do streets enable the movement of people and goods, their design also impacts overall well-being. Air pollution from traffic congestion is linked to cardiovascular morbidity (Allen et al., 2009), childhood incident asthma (McConnell et al., 2010) and lung cancer mortality (Filleul et al., 2005) among other long-term health impacts. People who live in areas with high traffic also report elevated levels of stress and face greater risk of being traffic collision victims.

In Los Angeles, these impacts are felt acutely on a local level as well. Thankfully there are tools to curb dangerous and unwanted traffic and their associated negative externalities, but these tools are not always easy to come by even if there is funding available. LA Walks, a non-profit pedestrian advocacy organization, produced a two part video series documenting the time-intensive experience of trying to get a single speed hump on a typical residential street and highlighting the sobering need for safer streets. In talking to one mother, she expresses a commonplace concern about street safety: “There are children who walk to school. There are many traffic crashes” (LA Walks, 2020). And yet, despite a community’s best efforts and spending hours organizing, speed humps can take years to finally be implemented. Basic safety and quality of life concerns are failing to be met. While some of these impacts are difficult to adequately measure, this failure is especially pronounced in the number of traffic collisions that occur annually in Los Angeles. Between 2012 and 2016, an estimated 14,230 pedestrians were struck on Los Angeles City streets, and 439 pedestrians lost their lives (Lopez, n.d.).

There is widespread and growing demand to calm traffic on residential streets, and this may not come as a surprise as there are quality of life benefits associated with living on a street with less traffic. The City of Los Angeles adopted a Vision Zero policy with the goal of eliminating fatal traffic deaths by 2025, less than five years from now.

But this vision will be difficult to achieve without a systematic and streamlined process for making the streets safer for residents and lowering cut-through traffic in residential neighborhoods. Now more than ever, the flow of traffic is determined by wayfinding applications. Travel paths are created through algorithms that prioritize efficiency and avoid traffic congestion. For a city like Los Angeles with approximately 6,500 miles of streets, this can be a big problem. Some argue that by providing clear visual and audible directions, apps allow drivers to focus on their immediate surroundings rather than navigating difficult to read signage or unfamiliar detours (Kerksieck, 2016). However, the more dominant perception in the public discourse sees the situation differently. Instead, the prevalence of wayfinding apps is viewed as a headache bringing traffic to streets that previously had no issues. But the phenomena of cut-through traffic is not new. In some ways navigation apps are simply bringing traffic issues to the forefront that, until recently, were only felt by residents on certain obvious cut-through corridors. So is there a solution?

Speed humps and other traffic calming interventions are used throughout the City of Los Angeles with very little data about the relative effectiveness of their implementation. Given the popularity of residential street traffic calming, especially compared to more contentious conversations that surface around proposed interventions on high profile busy streets, there could be promise with nimble residential traffic calming if it is effective. Other cities like the Cities of Berkeley, Seattle and Portland have proven that traffic calming works in their unique built environment. But these cities are relatively small and have been pursuing traffic calming for decades longer than Los Angeles. This research will assess traffic safety outcomes of specific traffic calming elements in Los Angeles with a sensitivity to the cost of implementation, an important constraint that Los Angeles is bound by given its size and sprawling network of streets.

This report will address the cut-through traffic problem, framed by the central question:

How effective are the low-cost traffic safety interventions that the City of Los Angeles frequently uses on its residential streets?

I will answer this question by analyzing traffic characteristics and collision data to compare different traffic interventions. Interventions covered in this report are speed humps, road diets/bike lanes, partial closures and stop signs. While stop signs are technically a form of traffic control (regulating right-of-way at an intersection) rather than traffic calming, they are widely seen as a tool to address speeding and therefore are included for comparison as well. Additionally, bike lanes are not specifically designed to slow down cars or restrict the flow of traffic, they are primarily designed to protect bicyclists. As discussed later, bike lanes and road diets have been found to have a calming effect on traffic.

Navigation Apps and Cut Through Traffic

While traffic calming as a practice is decades old, it has found a new challenge over the past few years in the form of most drivers having access to route-mapping applications on their cell phones that let them circumvent traffic and increasingly test the effectiveness of traditional traffic calming methods. Navigation apps encourage users to take on both an active and a passive role in using the app which facilitates a dichotomy. On the one hand, applications increase accessibility and warn motorists of hazards, traffic jams and enforcement checkpoints. Apps such as the popular "Waze" even encourages users to provide an account of what they see on the road. This is not inherently harmful and can in some cases provide a good to fellow travelers. Some argue that this democratizes the road and makes streets more user friendly (Kerksiek, 2016) by making drivers aware of unusual conditions and letting them anticipate certain elements so they can focus on their attention without being distracted by navigating a physical map or unfamiliar conditions and signage. On the other hand, these apps invite traffic to streets that may not have previously had much traffic, or be intended to carry the newfound trips accommodating frustrated and impatient drivers. This raises legitimate quality of life and safety concerns from local residents contending with the influx of added traffic on their streets.

The so-called "Waze effect" describes the negative impact of navigation apps upon residential neighborhoods (Osagie, 2018). The flow of motor vehicle traffic is determined by algorithms that facilitate movement in applications.

Without data from technology companies, it is difficult to pinpoint whether traffic has been routed into a neighborhood as a result of apps, but transportation professionals are finding other ways to proxy this pattern.

This report aims to address cut-through traffic in evaluating average daily travel (ADT) and traffic speeds before and after calming devices are introduced to evaluate performance rather than conducting an origin-destination study; but it is a method worth using for future research.

Overview of Traffic Calming

Traffic calming is the use of physical design interventions including signage, roadway geometries and markings to lower vehicle speeds and throughput, to achieve increased safety and walkability (ITE, 1999). Jurisdictions often implement traffic calming programs on a temporary basis to assess program success and resident satisfaction. The American Association of State Highway and Transportation Officials (AASHTO) recommends use in "lower speed urban areas and in speed transition areas such as near the urbanized limits of small towns" (Ewing, 2017). Interventions can be most impactful in areas with lower pedestrian counts because the mere presence of pedestrians in high volumes has itself proven to make drivers slow down and be more aware of their surroundings (Jacobsen, 2003), giving credence to the popular adage that there is "safety in numbers".

The goal of traffic calming is to alter user behaviors to achieve some or all of the following goals: reduce traffic volumes, slow vehicle speeds, and/or reduce the severity or overall number of traffic collisions. Sometimes there are secondary goals of traffic calming such as reducing the need for police enforcement, promoting bicycling and even managing stormwater infiltration into the ground (ITE, n.d.). Traffic engineers categorize calming interventions into four main types: vertical/horizontal deflection, routing restriction and street width reduction. This report will include vertical deflection (speed humps), routing restriction (partial closures) and street width reduction (bike lanes), in addition to a traffic control device which is not in this list (stop signs). The selected interventions are representative of common measures that are used throughout North America (ITE, n.d.).

When a traffic calming program is first introduced, residents may be hesitant or worried that these changes will negatively impact their daily lives. Issues that are commonly raised when implementing a traffic calming program are how it can affect: emergency vehicle access; liability in the event that someone crashes into or as a result of the calming and interventions' (i.e. speed humps) impact on bicyclists during navigation (FHWA, n.d.). Measures with vertical deflection like speed tables are concerning to fire departments because of the risk of damage to fire vehicles; however, early studies have found no evidence to substantiate this claim (FHWA, 2017). The consensus among transportation professionals is that traffic calming is a necessary part of a complete community, one where people can safely and peacefully coexist with local traffic circulation (ITE, n.d.). As discussed in the literature review, studies have found that speed humps lowered emergency response times, but only by a marginal amount. Without slowing vehicles down, unmitigated vehicle flow can lead to dangerous collision incidents, increased air pollution, lower bicycle presence and an overall less vibrant community.

Literature Review

There is a broad category of literature that discusses traffic calming - from raised crosswalks in Ancient Rome meant to slow down horse traffic, to the contemporary woonerf in the Netherlands. To narrow this category down, the object of this literature review is to provide a narrative that will draw a few highlights from traffic calming history and contemporary practices that relate to the research question at hand. I will begin by discussing the history of two separate but related motives with which traffic calming originated including reclaiming the public realm and regulating driver behaviors. Additionally, I overview studies that evaluate the effectiveness of traffic calming on traffic speed and volumes. I close with a discussion of secondary benefits that arise from traffic calming programs including property values and the effect on non-vehicular traffic volumes.

Traffic calming is distinguished from other roadway designs that do not compel drivers to drive slower like street furniture and lighting features. Aside from the fundamental goal of reducing vehicular speeds, other objectives of traffic calming include improving walkability, improving air quality (Bellefleur & Gagnon, 2012), reducing crime (Lockwood & Stillings, 1998) and equitably balancing transportation modes.

An Abridged History of Traffic Calming

Traffic Calming as *Reclaiming Public Realm*

Before automobiles dominated the streets, children used to play in the streets and users were pedestrians at large. After the advent of the motor vehicles, children were no longer welcome on the streets and pedestrians who crossed or wandered in undesignated parts of the road were labeled as nuisance "jaywalkers." In a comprehensively researched book called Fighting Traffic: The Dawn of the Motor Age in the American City, University of Virginia professor Peter Norton argues that the American City underwent a fundamental change that is rarely acknowledged these days. Indeed, streets had to be reconstructed not only physically but also socially. Rather than calling it an evolution as it is often portrayed in traditional transportation discourse, Norton calls it a revolution that was sometimes even violent to achieve the end of removing people from their beloved streets.

> "Beneath the grief and anger of many safety reformers lay an old assumption: city streets, like city parks, were public spaces. Anyone could use them provided they did not unduly annoy or endanger others… When city people talked about the new traffic problem, they did not all mean the same thing. Pedestrians complained of the automobile's trespass upon their rights. Parents dreaded the new threat to their children's safety… These groups shared a kind of conservatism that attached them to long-standing constructions of the city street. In the automobile they saw a threat to established customs. Upholding time-honored ways, these groups tended to perceive the automobile's intrusions as threats to justice" (Norton, 2011, p. 129-148).

Norton's quote illustrates that the version of history that we have inherited does not include the extent of initial hostility and discontentment toward vehicles on public roads. In the early years, everyone blamed the car and the driver for injuring members of the public but a careful public relations campaign was set up to use a term of ridicule - "jay" (a rural person) - and attach that to a walker. The implication of the campaign was that if you did not know how to navigate the street, you were an ignoramus jaywalker. Relentless campaigns from people who wanted cars to have a future meant that jaywalking became part of the vernacular by the 1930s.

By equating pedestrian activity on the streets with being uncivilized, the campaign to get vehicles on roads was highly successful in altering the social and physical landscape of cities around the world. What was once unthinkable became commonplace.

Like many pivotal civic rallying efforts, traffic calming originated as a grassroots movement. With the rise and growing dominance of the automobile in the mid 1900s, pedestrians were increasingly pushed to the margins and suffering sometimes fatal consequences. Given that pedestrians had dominated cities for centuries prior to the automobile, it seems inevitable in retrospect that there would be some pushback. Famously, in the late 1960s, residents of the Dutch town called Delft successfully fought against growing cut-through traffic by transforming their roads into "Woonerven," or "living streets" (Kjemtrup & Herrstedt, 1992). Residents tore up portions of pavement or brick on their streets in the middle of the night and planted furniture along the streets so that cars had to move around the new obstructions slowly and carefully. Woonerf movements were about creating areas where people are the priority.

The same need to reclaim the public realm as the Dutch living streets was found in the United States as well, when Donald Appleyard developed the concept of "livable streets" (Appleyard, 1980). Inspired by woonerven principles, a livable street is one that is a sanctuary for those that live on it. Livable streets are not exclusionary, but they are protected to allow for residents to live, work and play in their community without fear for their safety. The City of Berkeley incorporated Appleyard's findings when they installed the very first diverters (concrete bollards and wooden planks) in 1964 to minimize cut-through traffic adjacent to San Pablo Park (City of Berkeley, 1998). There was a rising concern among residents about cut-through traffic through residential streets as the City was growing larger in size. The rising frustration with increased traffic volumes in Berkeley continued throughout the decades. In response, the City installed various traffic calming interventions including speed humps, traffic circles, chicanes, curb extensions and partial street closures among others. Parallel to efforts in other parts of the world, cities in California have long been reclaiming streets for public use beyond automobile thoroughfare.

Traffic Calming as Regulating Driver Behavior

Another origin for traffic calming is to regulate driver behavior to increase pedestrian safety. The primary focus of this report is interventions that are used to regulate traffic but it is important to recognize that both motivations are separate but related paths, intended to reclaim space from cars. Soon after Woonerven became a popular movement, the government adopted the concept and woonerfs became signified by a physically altered streetscape where pedestrians have priority, complemented by signage telling drivers that they are entering a different type of road (FHWA,1994). The goal was to create an obstacle course for motorists, to turn what was a hostile autocentric environment into a livable streetscape lined with seemingly natural extensions of nearby homes. Variations of woonerven urban designs were adapted in other countries including France, Israel, Japan and England. The traffic calmed streets have also evoked nicknames like "stille veje," or "silent roads" and the "Tempo 30" zones referring to their slower speeds (30km/hour, or about 18mph) in Germany (Herrstedt, 1992).

An early prominent study of traffic calming occurred in the 1970s, when the German government tested area-wide traffic calming in six towns. While the study resulted in no changes to traffic volumes, there were several benefits. Noise levels decreased, vehicle speeds reduced by 50% (FHWA, 1992), crash severity went down and air pollution reduced significantly (Tolley, 1990). Subsequent studies would continue to show similar benefits associated with traffic calming. While the popular "living street" model has shown success abroad, traffic calming of such intensity is rare in much of the United States, and especially in Los Angeles. However, the bottom line resonates across borders - the presence and speed of traffic affects everyday quality of life and in some cases change has come about as a consequence of residents taking matters into their own hands to protect their access to public space.

In the United States, an early adoption of traffic calming can be found in Stevens Neighborhood in Seattle, Washington. The City adopted what is now the backbone of their calming program. In 1971, Seattle tested traffic circles between 12 blocks in Stevens Neighborhood using temporary materials. Once the trial run was over, the City adopted permanently landscaped circles (ITE, 1999).

It was found that intersection collisions reduced by 77% (Rutherford, McLaughlin & Borstel, n.d.). This experience has laid the critical framework used for traffic calming plans across the United States. Best practices learned include temporarily testing area-wide treatments, garnering public support and conducting before and after studies before permanently altering the streetscape (Rutherford, McLaughlin & Borstel, n.d.). While traffic circles are not quite ubiquitous the history and process behind their development in Seattle offers a model of success that is built on iterating and testing concepts by measuring their impacts.

Cut-through Traffic in Los Angeles

In recent years, the impact of Google Maps and Waze have become an overwhelming concern in Los Angeles. Panicked first time drivers in once-tranquil areas can become confused in unfamiliar neighborhoods that may feature steep hills, windy turns and other design elements that were not intended for thoroughfare. Recent media coverage reflects the disconnect between navigation apps and local residents throughout LA city and county. For instance, residents in the Encino neighborhood of Los Angeles, have asked for the County of Los Angeles to curb cut-through traffic resulting from apps diverting motorists to speed through their neighborhood. One resident pleaded to LA Times columnist Steve Lopez to amplify their call for action, stating "Waze has killed our street. Ruined our neighborhood." Another resident concerned for her child's safety, reflected on the imminent threat of cut-through traffic "If my kid's ball rolled into the street, he would probably die" (Lopez, 2018).

Additionally, Echo Park residents near Baxter Street share the same frustrations. Baxter Street is one of Los Angeles' steepest streets at a grade of 32%. Unsuspecting drivers started falling victim to having their navigation applications directing them onto Baxter Street with little awareness of the steep road conditions. If a driver were driving on the steepest inclines at Alessandro Avenue or Lakeshore Avenue, they would not see the pavement in front of them - just sky. The inability to see what is ahead of you, combined with weather hazards and confusion has led to many incidents over the years. The road was designed a long time ago and never meant to carry much traffic (Lopez, 2018).

LADOT addressed this issue by partially closing Baxter Street and making it a one-way street in the downhill direction at key locations, lowering the volume of traffic and potential for cut-through pathways. In the Analysis section of this report, I address the Baxter Street case study in more detail and address the effectiveness of the partial closure as a whole.

This frustration with navigation apps is shared with other residents in communities across California (MacFarlane, 2019) and the US as a whole (Greenfield, 2020). As such, the Waze effect is not simply a buzzword, but a real point of contention for residents in neighborhoods that are victim to the rerouting of traffic onto the streets that their children play on. It is a problem that has stemmed from navigation app algorithms that prioritize efficiency and have unintended ripple effects.

Traffic Calming as Speed Regulation

One primary goal of traffic calming is the reduction of vehicle speeds because this is a major risk factor in roadway safety; and in the City of Los Angeles speed reduction is a fundamental tenet of Vision Zero (LADOT, n.d). Broadly, literature points to the effectiveness of traffic calming in reducing speeds (Smith & Appleyard, 1980). The associated decrease in speed lowers the presence of speed differentials in traffic flow, which also lowers the probability of collision (Ewing & Edwards, 2009). A study in Salt Lake City, Utah conducted spot speed studies to analyze the effectiveness of speed humps and found that the average reduction in 85th percentile speed (3.4MPH) was a significant change, on flat terrain but not uphill or downhill (Cottrell, Kim, Martin & Perrin, 2006). Another report by Ewing (2001) gathered data from dozens of before-and-after studies conducted by ITE and FHWA. Ewing reviewed the average speed after traffic calming using the standard deviation from the average for many interventions, including speed humps, raised intersections, roadway narrowing and closures. With the caveat that the before-and-after periods for the studies reviewed are not the same, he found that raised intersections and roadway narrowing have the least impact. The device with the greatest impact on speeds was speed humps. They found that speed humps reduced speeds by 7MPH or -20% (Ewing, 2001, p.2).

An issue that is commonly raised when implementing a traffic calming program is emergency vehicle access (FHWA, n.d.). It is understandable to be concerned about emergency and service vehicle access given that speed humps, and other measures will increase trip times for all vehicles, but only by a matter of seconds. The City of Berkeley conducted an evaluation of delay for emergency vehicles and found that 12-foot speed humps result in an increase of 10.0 seconds per hump for trip time, and 22-foot speed humps increased three seconds per hump.

Similarly, a study was conducted to evaluate the City of Portland's Traffic Calming Program on emergency response times. Six fire vehicles of differing characteristics were used, with 36 different drivers. They videotaped vehicle speeds with a radar gun in shot. The authors found that traffic circles delay response times by 1.3 and 10.7 seconds while 14 foot speed humps cause between 1.3 and 9.4 seconds of delay per hump, 22 foot speed humps cause a delay between 0.0 and 9.2 seconds of delay per hump (Atkins & Coleman, 1997). Findings from Austin (Bunte, 2000), Portland (City of Portland, 1998) and Berkeley (City of Berkeley, n.d.) validate the concern that speed humps, bumps and traffic circles can cause minor delay for emergency vehicles.

Traffic engineers are aware of the potential minor delays. To address emergency response concerns, measures can be kept off emergency response routes. Further, in coordination with fire departments and other agencies, traffic professionals can design calming interventions to accommodate emergency events. Speed humps can be made longer to reduce delay time, traffic circles can be designed to be mountable by large vehicles and bollards/diverters can be removable (Ewing & Kooshian, 1997).

Traffic Calming as Regulating Traffic Volumes

Traffic is commonly referred to as a liquid that flows where it is directed, but the literature proves that it behaves more like a gas that expands to fill all available space (Newman & Kenworthy, 1999). Many traffic calming programs aim to reduce cut-through traffic (City of Paso Robles, 2004; Seattle Department of Transportation, n.d.), however, studies are conflicting about whether traffic calming interventions have the ability to effectively do so without providing alternative routes for vehicles to be re-routed to.

The impact of traffic calming on daily traffic volume is highly dependent on the quality and availability of alternative routes (Ewing, 2001). A road with traffic calming measures is less desirable for motorists. It is important to remember the split between local and cut-through traffic when considering traffic volumes as well. To demonstrate this principle, Ewing highlights a case study in Bellevue, Washington. The study was conducted at SE 63rd street and 162nd Avenue SE, but the former route did not have a parallel route available to through traffic. Both were treated with 12-foot speed humps. Volumes on SE 63rd street increased from 2,456 to 2,593 vpd (+5.6%), whereas on 162nd Avenue SE decreased from 1,472 to 1,071vpd (-27.2%). The volumes on 63rd are the result of having no parallel route available for through-traffic to be diverted to. The ability of traffic calming to reduce traffic volume remains inconclusive or dependent on context-sensitive measures being applied.

Traffic Calming and Collision Reduction

The magnitude of safety benefits is often understood by comparing collision severity and frequency rates before and after interventions are installed. One scoping review of traffic calming collision literature scanned 15 case studies ranging from Europe, Australia and North America, collision frequency reduced by between 8% and 95% (Zein et al., 1997). Another systematic review of 22 before-and-after studies found that there is significant heterogeneity in the findings for road user injuries and total number of crashes (Bunn et al., 2009); however, speed homogeneity from traffic calming can result in overall collision reductions.

The Canadian National Collaborating Centre for Healthy Public Policy (CNCCHPP) did a literature review on urban traffic calming and health. The Centre found that the decrease in collisions is related to several mechanisms. For one, some interventions used for traffic calming like a traffic circle can reduce the number of points of conflict at a traditional intersection. There are fewer opportunities for collisions. Another factor is that strategies that lower traffic volume by channelling traffic elsewhere also channels the risk elsewhere, all other factors being equal. Displacing the collisions from one road to another contributes to a decrease in collisions in the traffic calmed area. There is an improvement of visibility of non-motorized traffic (i.e. pedestrians and bicyclists). Finally, the more complex environment established by a traffic calming program can increase driver alertness (Bellefleur & Gagnon, 2012).

The CNCCHPP summarizes the reasons that traffic calming results in a decrease in collisions with the following mechanisms (adapted from Bellefleur & Gagnon, 2012):

1. Increased driver alertness
2. Speed homogenization
3. Reduced vehicle traffic volume
4. Reduced points of conflict
5. Improved pedestrian visibility/reduced exposure

Additional Benefits of Traffic Calming

Traffic calming is normally considered an engineering issue but the social benefits are noteworthy. (Crouse, 2004) Increasingly, traffic calming is applied for its complementary benefits such as promoting more active travel such as walking and bicycling. The City of Berkeley conducted a study on two blocks along Milvia Street in 1990 to assess curb extensions, chicanes and speed humps to assess how it affects bicycle traffic. Before the intervention, there were 125 bicyclists on the corridor. After, the count increased to 222, a 77.6% increase in bicycling activity (City of Berkeley, n.d., p.7). Berkeley's findings highlight another benefit to calming devices, which is to encourage more bicycling and pedestrian activity in absence of vehicular traffic. The neighborhood benefited from a quieter environment for walking, safer crossing and overall reduction of severe traffic incidents (City of Berkeley, n.d., p.7). As such, traffic calming interventions have proven to reduce the overall severity of collisions and create a pleasant environment for pedestrians overall.

Although traffic calming programs are focused on improving safety, some studies point to a wide range of additional advantages like increased property values, improved business and overall non-vehicular activity. For example, the City of West Palm Beach in Florida used traffic calming as part of a redevelopment plan to reduce crime and revitalize the downtown. The areawide revitalization used New Urbanist principles with raised traffic calming measures including traffic circles, closures, intersections, raised crosswalks and neckdowns.

In addition to successfully curbing crime, the City also found that street beautification and calming resulted in a marked increase in property values in older neighborhoods (Ewing, 1999; Transportation Research Board, 1999). The average property values in the Old Northwood neighborhood increased from $65,000 in 1994 to $106,000 in 1997 (ITE/FHWA, 1999). Further, communities that invest in traffic calming with pedestrian and bicycle facilities find that residents will sell their cars and take public transportation, walk, bicycle or even join a carpool (Boarnet and Greenwald, 2001). Bike lanes have proven to have a positive impact on local businesses. Four years after installation, 65% of merchants in one study of Valencia Street in San Francisco reported that bike lanes adjacent to their stores have had a positive impact on sales (Drennen, 2003). Overall, traffic calming programs can improve more than just safety - they can enhance vibrancy in a community through various means depending on their deployment.

Literature Review Takeaways

Contemporary traffic calming has a long history that dates back almost as far back as the automobile itself. While navigation apps are relatively new, there has long been a desire to better regulate car movement. Some elements of traffic calming have their roots in traffic engineering and enforcement while other aspects have come from grassroots rallying efforts to reclaim public space. Over the years traffic calming has evolved in its application but the consensus is clear, traffic calming has a documented effect of achieving the goals it sets to achieve: controlling speed, reducing crashes, and managing traffic volumes. There are also secondary benefits that can come from implementing a traffic calming program like increased property values, increased local business activity and increased use of active transportation. Metrics to assess whether a traffic calming program has worked can include collision severity (lower bodily harm), vehicle speeds, quality of life and resident enjoyment of the new streetscape.

Much of the past research has focused on safety and the social benefits of traffic calming programs overall. However, a lot of key research is aging, and very few studies that focus on the City of Los Angeles or take into account the fiscal constraints many jurisdictions face.Traffic calming is an important program worth considering in any city, but especially in Los Angeles where in 2019, citywide collisions totaled over 54,000, with a tragic total of 236 fatalities (LAPD, 2019).

It is necessary to understand the effectiveness of existing measures to evaluate how to move forward with directing resources in the future. This report builds on existing research and considers the cost associated with interventions identified, understanding that low-cost is essential to have interventions that are scalable and can be installed quickly in a short amount of time.

Data and Methodology

This report examines the relative cost-effectiveness of four popular and low-cost traffic calming measures found in Los Angeles (Figure 1).

Speed Hump | Bike Lane | Partial Closure | Stop Sign

Figure 1. Traffic calming measures addressed in this study include speed hump, bike lanes, partial closures and stop signs.

It is worth noting that stop signs are a traffic control device, not a calming device, but they are included in this study for comparison since they are typically included in calming programs. Additionally, bike lanes, unlike the other measures, are not designed to slow down cars or restrict travel but they are designed to protect bicyclists. They are included because traffic professionals use them to decrease roadway conflicts, reduce speeding and encourage non-vehicular travel overall (Burden & Lagerwey, 1999; Knapp et al., 2014; Road Diet Case Studies, 2015).

To measure the potential safety benefits of these treatments, I evaluate the following metrics of roadway safety through before and after analyses:

- Traffic speed
- Traffic count
- Collision frequency
- Collision severity

Collectively, these metrics assess major pain-points related to cut-through traffic concerns and reflect insights that can help guide the City in its quest to make streets safer.

Lowering the number of traffic incidents is especially important to measure the success of a traffic calming measure based on Los Angeles' Vision Zero goal of eliminating traffic deaths by 2025. Vision Zero is guided by an understanding that people will make mistakes on the road, but that roadway design should reduce the severity of collisions and that slowing vehicles down will help this cause (LADOT, n.d.). To conduct a final comparative cost-benefit assessment of interventions, I summarized the typical costs in a table (Table 1). I retrieved typical costs for traffic calming measures from the Federal Highway Administration (FHWA). To conduct a final comparative cost-benefit assessment of interventions, I summarized the typical costs in a table (Table 1). I retrieved typical costs for traffic calming measures from the Federal Highway Administration (FHWA).

Selected corridors for study are dispersed throughout the City of Los Angeles (Figure 2). In general, I selected corridors to reflect a range of built environment and demographic characteristics. Median income for neighborhoods surrounding selected segments range from $33,000 to $120,000. Similarly, there is great variety in the land use of neighborhoods - some predominantly single family homes, while others mixed-use or multi-family areas. The sample is limited to roadways with interventions that were installed between 2018 and 2019 based on pre- and post intervention data availability. As such, this report is not exhaustive but it is comprehensive and offers a snapshot of the city as a whole.

The speed hump corridors I studied were selected randomly from an LADOT spreadsheet of speed humps installed between 2018 and 2019 that I filtered based on data availability. Similar lists were provided for the other measures studied. I included a range of residential neighborhood types (Appendix B). Bike lanes, turn restrictions/ roadway closures, and stop signs were more limited in sheer quantity and even more so when accounting for data limitations but were also random to the extent that their implementation was not directed by the City's Vision Zero program. I excluded segments from the sample for which I could not gather sufficient collision data to perform a before-and-after analysis. The resulting selected segments are representative of local roadway and residential composition types across Los Angeles.

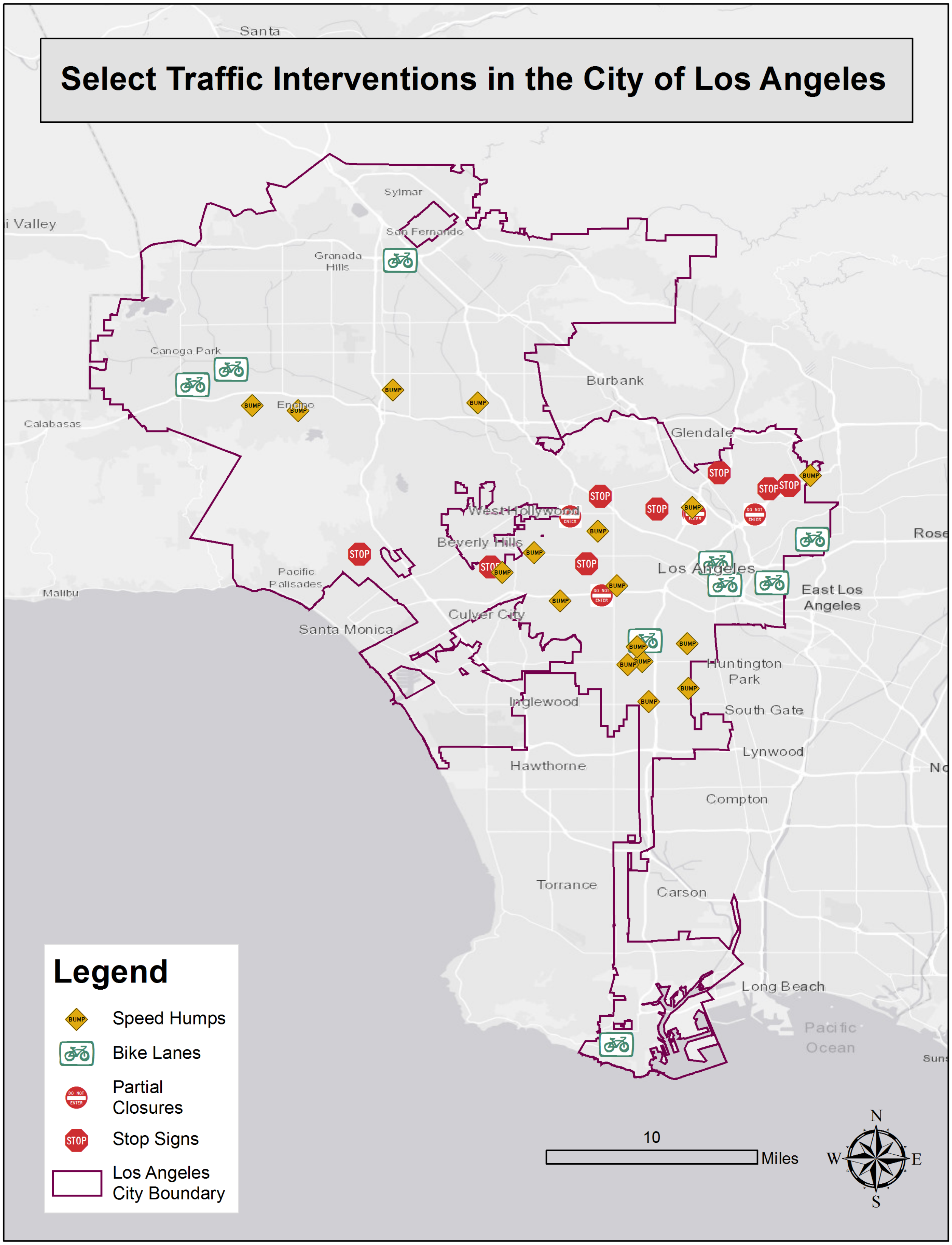

Figure 2. Map of selected traffic calming interventions throughout the City of Los Angeles.

To retrieve data related to traffic speed and volume, I relied on Streetlight Data Analytics. Streetlight Data is a platform that gathers anonymized location data from smart phones and navigation devices in connected cars and trucks, in addition to other reliable sources like parcel data and digital road network data. The platform has developed a robust view into Los Angeles' vast network of roads, bike lanes and sidewalks (Streetlight Data, n.d.). Streetlight only began collecting data validated by permanent counters in 2017. To analyze collision data, I used UC Berkeley's Traffic Injury Mapping System (TIMS). TIMS has reliable data for incidents between 2009 and 2019, whereas 2020 and onward is provisional and still subject to change. The mapping system was developed by UC Berkeley's Safe Transportation Research and Education Center to provide access to a data-driven methodology to assess the impact of a project upon a community. California crash data retrieved from the Statewide Integrated Traffic Records System (SWITRS) is geocoded onto TIMS (UC Berkeley, n.d.). As such, based on the limitations of these sources, interventions installed before 2018 or after January of 2020 would produce unreliable or inconsistent data and were not included in this report.

An important limitation is that traffic data from 2020 may be skewed because of the COVID-19 pandemic. Los Angeles and Ventura County VMT decreased by 30% between December 2019 and March 2020 (ITE, 2020). In the Limitations section of this report, I review the potential impacts of COVID-19 on my analysis.

Traffic Speed and Count

I used Streetlight Data to extrapolate speed and traffic count data from selected segments (Appendix C). Streetlight Data is an interactive platform with aggregated data from 2016 onwards, which allows users to analyze travel patterns for a variety of modes.

In my sample, there are 38 segments in total: 17 speed humps, 8 stop signs, 4 closures and 9 bike lanes. I extrapolated traffic counts and speeds from the year before and after the interventions were implemented. Traffic counts and speeds are exported for every day of the week (Monday to Sunday) from 12AM to 11:59PM. I looked at it over a longer period of time.

On Streetlight, I created a new segment analysis for each segment from one pass through gate to another. I selected "All Vehicles" for the Mode of Travel option, with "Miles" as the unit of measurement. To add road segments, I searched for each road manually and clicked on all sub-segments to create the larger zone. For the data period - I entered 12 months before or after each intervention was installed. After I confirmed the analysis parameters, Streetlight runs and exports the analysis in .CSV form. I created pivot tables in Microsoft Excel after downloading the data from Streetlight. I sorted by "Day Type" to highlight "All Days," and I sorted by "Day Part" to highlight "All Day" (12AM to 11:59PM). Using the AVERAGE() function I calculated the mean Average Daily Traffic and Average Segment Speed for all segments. I rounded the traffic count numbers up because there are no half vehicles. I rounded speed by two decimal places.

I assessed the % change of vehicle speed/counts and performed a paired t-test bound by a 95% confidence interval to determine if the change is statistically significant. A paired t-test is used to test the mean difference between two dependent observations of traffic counts/speeds before and after the intervention was introduced. This accounts for the variability in the road conditions. I used Microsoft Excel's Data Analysis tool to compare the means (Frost, n.d.). If the p value is less than the significance level of 0.05, I will reject the null hypothesis. The p value is a measure of statistical significance, which helps add a level of validation; however, statistical significance alone will not make the results conclusive one way or the other. The sample included in this report are limited to a few key locations throughout Los Angeles, and while they provide an insight into traffic calming, they are not painting the entire picture. The statistical significance and related findings can be found in Appendix A but the main findings are highlighted in the following sections.

> Null hypothesis: There is no statistically significant association between the introduction of a speed hump/partial closure/bike lane/stop sign to a road segment and post-measure traffic count/traffic speeds.
>
> Research hypothesis: Traffic volume/traffic speeds are lower after the traffic calming measure is introduced to the segment.

Incident Rates

The literature is conflicting about whether traffic calming induces statistically significant decrease in vehicle counts or speeds (Ewing, 2001). For this reason, I also addressed traffic collision rates to see whether the interventions have made roads safer, regardless of whether speed or volume changed (Appendix C). I used the same time periods from my Streetlight analysis to summarize incident rates/severity along corridors using UC Berkeley's Transportation Injury Mapping System (TIMS). In addition to collision rates, I used TIMS to assess whether the severity of incidents has also reduced.

Collision severity values vary from 1 - Fatal (highest level of injury) to 0 (property damage):

- 1 - Fatal
- 2 - Injury (severe)
- 3 - Injury (Other Visible)
- 4 - Injury (Complaint of Pain)
- 0 - Property Damage Only (PDO) (PDO collisions not included on TIMS)

I used the segment collision rate formula to calculate the number of collisions per million vehicle miles (FHWA, n.d.). This formula is used as a comparison tool to assess whether the number of collisions have lowered after the intervention was introduced to each segment (see formula below). It also factors in exposure to indicate whether a road is more susceptible to collisions. Average daily traffic (ADT) is the number of vehicles that pass through the corridor on an average weekday during the selected year.

Segment Collision Rate Per Million Vehicle Miles Traveled Formula:

$$\frac{\#\text{ collisions per year} * 1{,}000{,}000}{\text{segment length (miles)} * \text{ADT} * 365\text{ days}}$$

Traffic Calming Techniques

There are four types of traffic calming techniques, detailed below.

> Vertical deflection: Temporarily alter the height of the roadway for the user, forcing drivers to adjust their speed like a raised crosswalk. This report will cover speed humps as a method of vertical deflection.
>
> Horizontal deflection: Alter the horizontal design of a roadway. This requires that drivers slow down to move around an object and include measures such as traffic circles or curb extensions.
>
> Routing restriction: Divert traffic off streets or prevent access through measures such as forced turns or landscaped medians. This report will cover partial closures as a method of routing restriction.
>
> Street width reduction: Reduce the width of the street to make drivers more aware of their immediate surroundings. This report will cover bike lanes as a method of street width reduction. Bike lanes are commonly used not only to encourage biking and provide a dedicated space for bicyclists, but to also have a calming effect on traffic overall.

Speed Hump

Speed humps are typically used in residential areas where there is low-volume traffic and lower speeds are desired. They are 3-4 inches high and between 12 and 22 feet long. The MUTCD (W7-1) recommends that vertical speed control devices should include a sign to warn drivers. They should be spaced out no more than 500 feet apart, and to achieve the greatest reduction in speed, they should be placed closer together (NACTO, n.d.). Motorists will slow down when they see a speed hump in an effort to avoid jarring their vehicle.

Speed humps also do not require the City to remove existing parking or travel lanes, which makes them more appealing to the public than other traffic calming methods like traffic circles that can require rearranging the public right-of-way. Recognized trade-offs of speed humps are that they can generate additional noise, and marginally slow emergency response times (City of Portland, 1998; ITE, 2018).

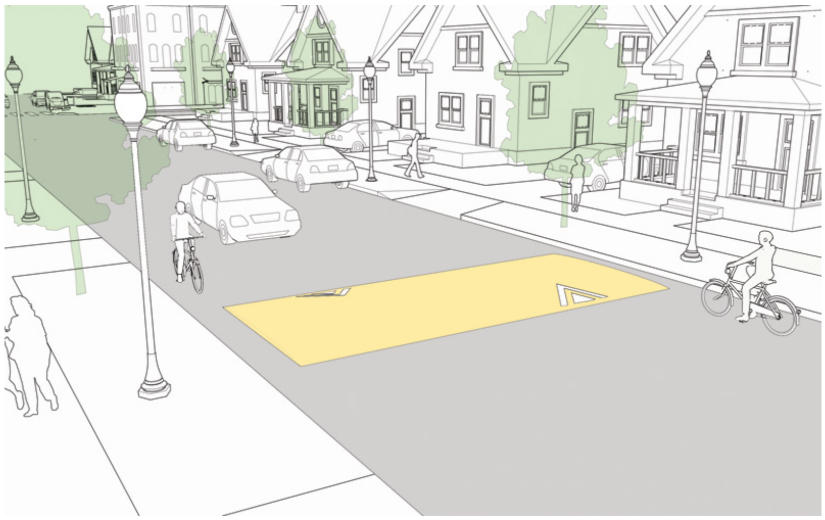

Figure 3. Rendering of a speed hump (NACTO, n.d.).

Bike Lane

Bike lanes are created by roadway striping or pavement markings that designate a portion of the road for bicyclists to protect them. They are not considered a traffic calming device. Although bike lanes are not directly installed for the purpose of traffic calming, reducing the number of, or narrowing, existing travel lanes to accommodate bike lanes can have a calming effect. Bike lanes are typically about 5-6 feet wide The MUTCD requires bike symbols and arrow markings to designate preferential use (NACTO, n.d.).

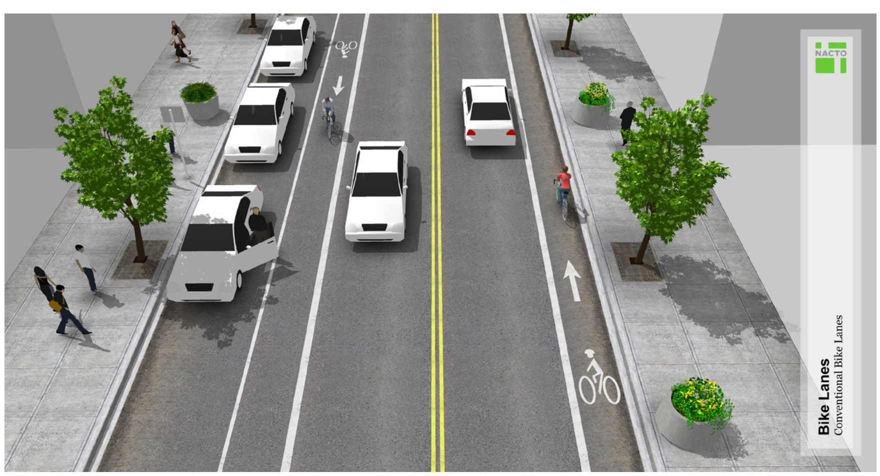

Figure 4. Rendering of a bike lane (NACTO, n.d.).

Partial Closure

Partial closures are facilitated using volume management techniques, including: the use of forced turning and restricting through movements, channelizing motor vehicles to turn right, choker entrances and median islands/diverters. They are used typically along residential streets and in Los Angeles are applied to discourage non-local traffic.

Figure 5. Rendering of a partial closure (NACTO, n.d.).

Traffic Calming Measure Cost

The measures that are included in this report like speed humps fall on the lower end of the cost spectrum. If they are effective, the city can use this information to scale citywide traffic calming and avoid reliance on state and federal grants, which may take years to secure and come with restrictions that may prevent the city from deployment in certain areas.

Common traffic calming measure costs are summarized in Table 1, retrieved from the Federal Highway Administration. An important consideration in traffic infrastructure investment is not only the cost of deployment, but also maintenance, labor, materials and the existing roadway context. Signs are the lowest cost alternative of traffic calming for measures where you are re-configuring the direction of travel, such as a partial closure. Other measures are costly and require extensive public consultation.

Costs in the City of Los Angeles may fall in the range of costs in the national average, but are typically higher due to the cost of materials and labor. For instance, a speed hump can cost between $4,000 and $7,000. Although costs can be higher in LA, relative cost ranges per device are consistent in indicating that certain measures like speed humps are generally cheaper than others.

Table 1. Typical cost of traffic calming measures throughout the United States (FHWA, n.d.).

Measure	Cost	Considerations
Stop sign, turn restriction signs, striping	<$2000	Cost of signs, pavement markings
Road diet (can include bike lane)	Can be implemented virtually at no cost if done in tandem with scheduled street resurfacing. Otherwise, the estimate is approximately $50,000 per mile.	Cost of signs, pavement markings
Speed hump	$2,000 - $5,000	Construction materials
Speed cushion	$3,000 - $6,000	Construction materials
Diverter	$6,000	Construction materials, drainage, landscaping
Median barrier	$1,500 - $20,000	Construction materials, landscaping, length/width
Chicane	$8000 - $10,000	Construction materials, drainage, existing curbing
Choker	$10,000 - $25,000	Construction materials, drainage
Traffic circle	$15,000 - $20,000	Construction materials
Median island	$15,000 - $55,000	Construction materials, direct function of length/width of median island
Mini roundabout	$15,000 - $60,000	Construction materials

Results

Appendix C contains detailed raw data and includes information about segment length, location, install date, traffic counts and speeds for each sample. Appendix C also contains details on collision types, counts and collision rates before and after interventions were introduced. I performed a paired t-test to evaluate the statistical significance of each intervention and then controlled for COVID-19 by removing interventions that were tested between 2019-2020 (Appendix A).

Speed Humps

Traffic Speed

I conducted a paired t-test on the sample of 17 speed humps and found that there was a significant difference between speeds before and after the speed humps were installed (Figure 6). Before, the average speed was 19.5 MPH whereas after one year the average speed went down to 18.0 MPH. For a detailed breakdown of the findings, see Figure A-1 in Appendix A and Appendix C. The results indicate that the speed humps were effective in reducing the speed of vehicles in each segment. As such, this finding validates the research hypothesis that there is a statistically significant difference between speeds before and after speed humps were introduced.

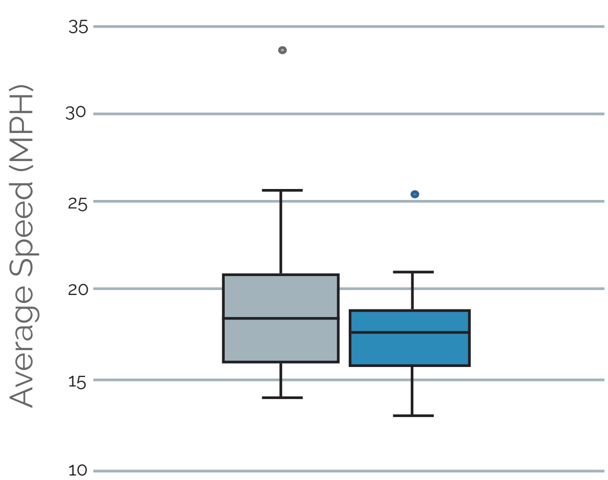

Figure 6. Box plot of average speeds one year before and after select speed humps were installed. Speeds reduced by approximately 1.5MPH, a change of -8%

To evaluate whether COVID-19 skewed the speed data, I performed another paired t-test on the 2018 speed humps and excluded those that were installed in 2019 (Figure A-1, Appendix A). There were a total of 8 speed humps in this smaller sample. There was a significant decline in speeds one year before and one year after the speed humps were installed in 2018. The average speed was 19.1MPH and dropped to 16.9MPH afterwards. The results suggest that the speed humps were significantly effective in reducing the speed humps of vehicles across sampled segments, even when you remove the possibility of COVID-19 altering how drivers behave and skewing the data. This finding validates the research hypothesis that there is a significant difference before and after speed humps were installed in 2018, even after factoring in the pandemic.

Traffic Count

My initial hypothesis was that speed humps would alter the volume of traffic because drivers would re-route themselves to other corridors; however, the findings suggest otherwise. I conducted a paired t-test on the entire sample of 17 speed humps to determine whether there was a statistically significant difference one year before and after they were introduced (Figure A-1, Appendix A). The initial results suggested that there was a significant difference. Before installation, the ADT was 2469 whereas after installation ADT was 2194, a decrease of 11.1% cars.

To assess whether COVID-19 skewed the traffic count data, I performed a paired t-test on just the 2018 speed humps. The results showed that there was no significant difference in traffic counts before and after the intervention was installed. One year before the pre-pandemic speed humps were installed, the ADT was 1932 whereas one year after, the ADT was 1847: a decrease of 4.4% of cars. The results suggested that COVID-19 may have skewed the traffic count data for the larger sample downwards. In 2018, the speed humps did not reduce the number of vehicles that passed through sampled roadways; however, although there was a decrease, it is important to understand that the small sample of 8 observations means that a test of equality between the two population variances would not be very powerful and the t-test results can give misleading results. As such, it is hard to say whether speed humps actually lowered the traffic count. Future research should have a larger sample size to evaluate the effectiveness of speed humps on traffic volumes.

Bike Lanes

Traffic Speed

Bike lanes, unlike the other roadway alterations discussed in this study, are not designed specifically to slow cars down or restrict travel. Rather, they narrow they make space for non-vehicular travel. There were 9 bike lane improvements including road diets, lane narrowings and street resurfacing projects in the selected samples. The results revealed that average vehicular speeds before bike lanes were introduced was 25.4MPH whereas after it increased to about 25.8MPH. Although the results may suggest that the bike lanes were not effective in reducing the average speed of vehicles in each segment, this finding may simply be due to the small sample size of 9 bike lanes. It is difficult to say that this result is an accurate representation of the impact of bike lanes on traffic. The results do not align with the research hypothesis but future research should evaluate a larger sample size to have a definitive result to report for this intervention.

Traffic Count

A paired t-test of the same 9 bike lanes revealed that there is no significant difference in vehicle counts one year before and after bike lanes were introduced (Appendix A). The average number of vehicles decreased slightly from 16,747 to 15,780, a decrease of about 6%. This result suggests that bike lanes were not effective in reducing the number of vehicles in each segment, or that there is no difference between the before and after periods. To check if there was a skew related to COVID-19, I looked at the bike lanes installed in 2018, of which there were two: one on Chatsworth St. and another on Alhambra Ave. A t-test was not required to check the significance. The Chatsworth bike lane had an increase of 64 vehicles in ADT and speeds lowered by -0.43MPH (-1.15%) and Alhambra Ave had an increase of 74 vehicles in ADT, speed lowered by -0.23MPH (-0.84%). It does not appear bike lanes had any significant effect on speed or traffic volumes within the limited tested sample. Although this finding does not meet the research hypothesis of change, this small sample is not representative of the effect of bike lanes on traffic speed or volume. Future research should evaluate traffic volume with a larger sample of road diet observations to better understand the relationship between traffic speed, volume and bike lanes.

Partial Closures

Traffic Speed

A paired t-test was conducted on 4 partial closures (Appendix A). Two of the closures (Baxter Street) involved converting a two-way street into a one-way street. This is a type of routing restriction so it was included in the study to assess whether speed or counts were reduced after the other direction of travel was "closed". There was no statistically significant difference between traffic speeds before and after the roads were partially closed. One year before, the average speed of vehicles was 23.3 whereas after it was 21.2. Although I cannot reject the null hypothesis, it is worth noting that the sample is quite small and not indicative of the effectiveness of partial closures to alter speeds; however, this finding is not surprising considering that turn restrictions and closures are more of a volume control method. Future research should include a larger sample of partial closures to better understand the relationship between closure and vehicle speeds.

Traffic Count

A paired t-test was conducted on 4 partial closures. There was no statistically significant difference between traffic counts before and after the roads were partially closed. One year before the roads were partially closed, the ADT was 9832 whereas after it was 7717, a decrease of 21.5%. The statistical significance may not accept the research hypothesis but that may have more to do with the small sample size rather than the actual significance of the measure, since a 21.5% decrease is noteworthy. Two out of the four partial closure samples were installed in 2018, before COVID-19. Although this sample would be too small to perform a t-test and calculate the test statistic, the traffic count and speeds before/after the closures are notable and suggest that this measure has the potential to reduce speed and volume. During the time pre-COVID-19, the ADT one year before was 1679 whereas after it was 1006, a decrease of 40%. Traffic speeds during that time for pre-pandemic time went down 30.2% from 19.2MPH to 13.4MPH. This makes sense given that traffic is diverted to other roads and drivers have to pay closer attention to signs as they navigate the closure.

Baxter Street Partial Closure

Baxter Street in Echo Park was altered into a one-way street and a significant portion of the traffic was rerouted. Of course, this type of partial closure is not a typical solution to safety problems but it is a notable one for one of Los Angeles' steepest streets with a 33% grade. The street received significant media coverage, residents referred to it as "an app-driven frenzy of spinouts, confusion and crashes". One resident said:

> "Rain is a huge problem. People start skidding and spinning. We had our garden wall knocked down twice, and my wife's car got hit in our own driveway. I've seen five or six cars smash into other cars, and it's getting worse" (Lopez, 2018).

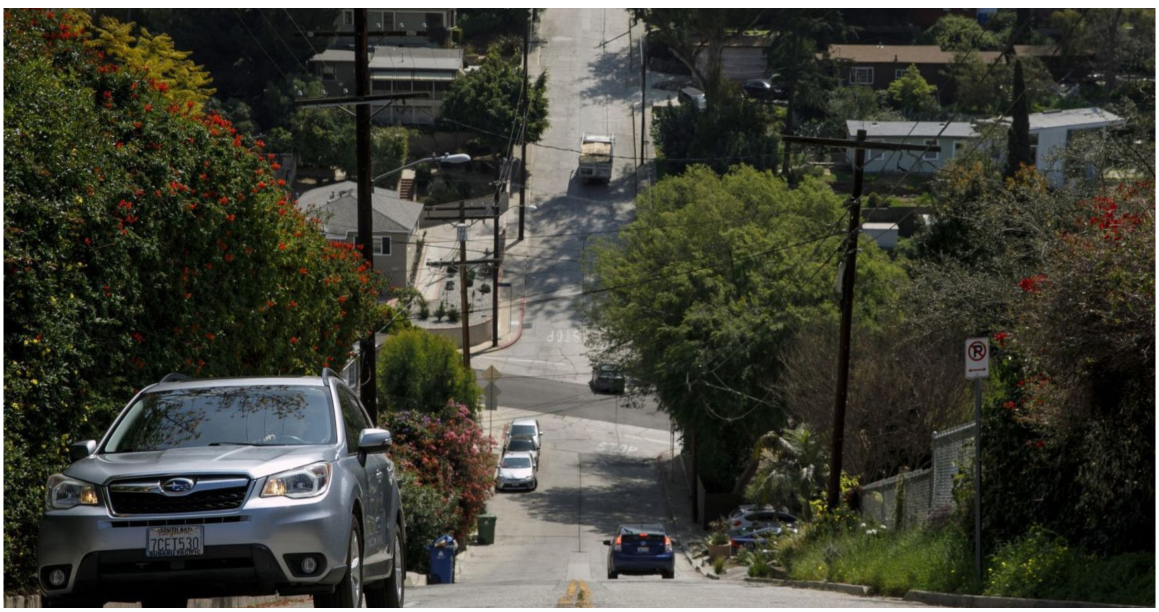

Figure 7. Image of Baxter Street, Echo Park, retrieved from Los Angeles Times (Lopez, 2018).

LADOT responded to resident concern by installing signs that re-route traffic with the following improvements (LADOT, 2018):

Conversion to a one-way street Westbound:

- Baxter St. from Allesandro St. to North Alvarado St.
- Fargo St. from Allesandro St. to North Alvarado St.

Conversion to a one-way street Eastbound:

- Baxter St. from North Alvarado St. to Lake Shore Ave.
- Cove Ave. from Cerro Gordo St. and Lake Shore Ave.

Two stop signs added:

- Baxter St. & Lake Shore Ave. intersection

Right-turn restriction between 4PM and 7PM, Monday to Friday:

- Baxter St. & Alvaro St. intersection

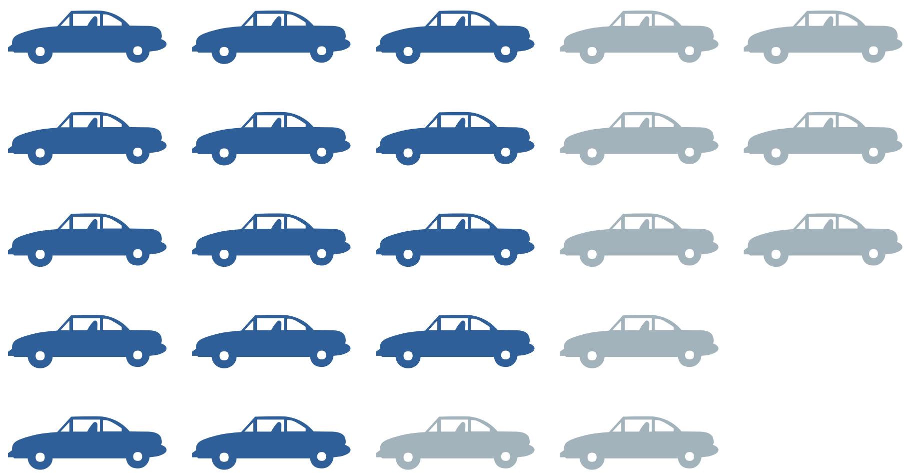

Figure 8. Partial closures on Baxter Street (Echo Park) reduced ADT by ~40%.

The results are very promising about the impact of partial closures on safety. There was a marked and dramatic decrease in volume and speeds. Traffic volumes dropped by approximately 40% after the conversion and speeds decreased by as much as 30% (Table 2 and 3). The Lake Shore to Alvarado segment saw speeds decrease from an average of 23.6MPH to 18.9MPH within a year after the partial closure in 2018.

Table 2. Average daily travel before and after Baxter Street Partial Closures.

Partial Closure Segment	ADT Before	ADT After	% Change
Baxter St. (Lake Shore Ave. to Alvaro St.)	2326	1446	-37.8%
Baxter St. (Lake Shore Ave to Lemonye St.)	1679	1006	-40.1%

Table 3. Average speed in MPH before and after Baxter Street Partial Closures.

Partial Closure Segment	Speed Before (MPH)	Speed After (MPH)	% Change
Baxter St. (Lake Shore Ave. to Alvaro St.)	23.6	18.9	-20.0%
Baxter St. (Lake Shore Ave to Lemonye St.)	19.2	13.4	-30.1%

Stop Signs

Traffic Speed

Stop signs are a traffic control device, but when there are signs of speeding on residential streets they are one of the first things people ask for. Because of their perceived ability to slow down traffic, they are included in this analysis for comparison to other traffic calming measures. A paired t-test was conducted on the sample of 8 all-way stop signs added to various intersections across Los Angeles (Appendix A). There was no statistically significant difference between traffic speeds before and after stop signs were installed. One year before the stop signs were installed, the average speed was 20.6MPH whereas one year after was 20.4MPH. As such, the stop signs made no apparent difference in vehicular speeds; however, this finding aligns with my understanding of traffic control devices. Stop signs are merely to control traffic and regulate right-of-way rather than primarily slow vehicles down. Perhaps some drivers are tempted to speed up at a stop sign to make up for the lost time.

Traffic Count

A paired sample t-test revealed that there is no statistically significant difference between traffic counts before and after stop signs were introduced. ADT for the all-way stop signs one year before they were installed was 7846 whereas after ADT was 7050, a drop in 10% of traffic volume. Although the decrease in volume may be related to the stop signs, it may also be related to the lower volume of traffic in the streets during the pandemic.

Collision Findings

Out of the 38 segments, 27 were removed from incident analysis because they had interventions installed in 2019 and I was unable to do a before-and-after analysis for those segments because SWITRS does not have complete data available after December 31, 2019 (Appendix C).

Given the much smaller sample of segments available for collision analysis (8 speed humps, 1 stop sign, 2 partial closures, 2 bike lanes), I summarized collision findings for all measures (Table 4) and then separately summarized findings for speed humps (Table 7) because they comprised more than half of the sample.

All Interventions

The most common collision type recorded was broadside, also known as a "t-bone" (Figure 9). This is when one vehicle collides into the side of another vehicle and they are in a perpendicular position; broadsides are also the most dangerous type of collision since there is little space between the driver/passenger and the point of impact. In my sample, broadsides collisions dropped by 36%, from 14 down to 9 collisions total (Table 4).

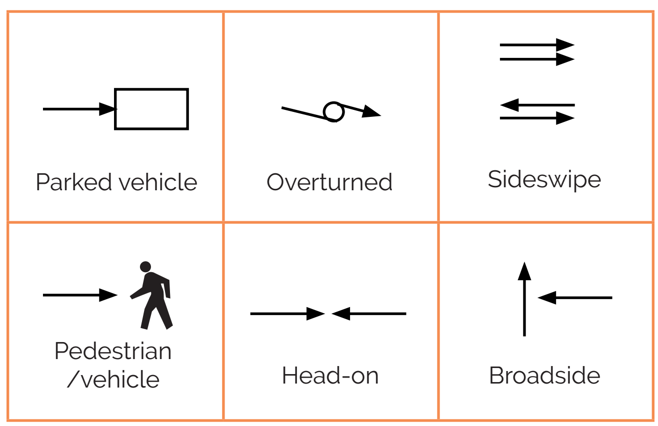

Figure 9. Common collision types.

This finding is particularly heartening since collisions cannot be prevented through design, but they can be reduced in likelihood and severity (Campbell & Okitsu, 2020). Additionally, vehicle/pedestrian collisions reduced by 50% from 4 incidents down to 2, which is a very positive finding in terms of safety. Head-on collisions dropped by 50% as well, from 2 down to 1. Parked motor vehicle collisions reduced by 100% from 1 collision in the year before and 0 after.

Total collisions reduced by 38%. Although such a small sample makes the % change appear to be dramatic, these findings point towards a net positive change due to cost-effective design changes.

Table 4. Collision types observed one year before and after all interventions.

Collision Type	One Year Before	One Year After	% Change
Broadside	14	9	-36%
Vehicle/pedestrian	4	2	-50%
Head on	2	1	-50%
Sideswipe	4	1	-75%
Parked motor vehicle	1	0	-100%
Overturned	1	0	-100%
Fixed object	1	1	0%
Other/not stated	2	2	0%
Total	**34**	**21**	**-38%**

Additionally, the segment collision rate calculations reveal that the number of collisions decreased from an average of 13.16 per million vehicle miles traveled (VMT), down to 5.03 per million VMT. Sampled roads had lower exposure to collisions after traffic calming. The most notable collision rate change were the partial closures in the sample - the absolute change in average collision rate before was 39.26 per million VMT one year before the intervention was put into place and dropped to 0.00 per million VMT after. Second to this, stop sign collisions per million VMT dropped from 43.88 to 19.85.

Interestingly, bike lane collisions per million VMT increased from 1.70 to 1.75, indicating an increase in collisions after they were put into place; however, this increase may be attributed to the COVID-19 pandemic when bicycle ridership increased as people had a new-found curiosity for non-motorized modes of travel. LADOT reported a 22% increase in bike ridership since 2017 which is an average that includes pandemic figures (Green Car Congress, 2021).

Table 5. Collision rate per million vehicle miles traveled one year before and after interventions were introduced.

Intervention	Avg Collision Rate Per Million VMT Before	Avg Collision Rate Per Million VMT After	Absolute Change
Speed Hump	10.56	5.25	-5.31
Partial Closure	39.26	0.00	-39.26
Bike Lane	1.70	1.75	+0.05
Stop Sign	43.88	19.85	-24.03

There are notable reductions in collision rates overall, and in collision severity (see Table 6 and Figure 10). For all interventions, the number of collisions decreased by 38% after traffic calming measures were introduced to selected roadway segments. Fatal and severe injuries reduced by 75% for all tested roadway samples.

Table 6. Injury severity one year before and after all interventions were introduced.

Injury Severity	One Year Before	One Year After	% Change
Fatal	1	0	-100%
Severe injury	3	1	-67%
Visible injury	13	6	-54%
Complaint of pain	17	14	-18%
Total	**34**	**21**	**-38%**

Although severe and fatal crashes are rare, their observed decline could indicate promise for achieving the admirable goal of eliminating traffic deaths in Los Angeles as part of Vision Zero. The caveat with these numbers is that the number of collisions along selected corridors were quite low to begin with, so the decrease may appear to be dramatic for percent change. Nonetheless, the positive results should not discount the success these low-cost measures achieved.

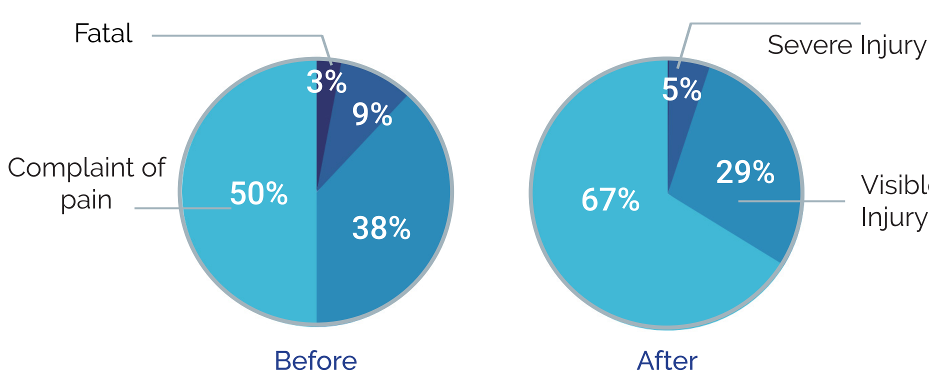

Figure 10. Collision injury severity one year before and after measures were introduced

Speed Hump Findings

Looking at speed humps separately, there are notable changes in collision and injury rates. One year after speed humps were installed, collision rates dropped by 46%. Although sideswipe and head on collisions increased, all other collision types dropped significantly. There were no vehicle/pedestrian collisions after installation, and broadside collisions reduced by 33%. The percent change values are large due to the small sample of 17 speed humps.

Table 7. Collision types observed one year before and after speed hump installation.

Collision Type	One Year Before	One Year After	% Change
Broadside	6	4	-33%
Rear end	2	1	-50%
Vehicle/pedestrian	3	0	-100%
Parked motor vehicle	1	0	-100%
Not stated/other	1	0	-100%
Side swipe	0	1	+100%
Head on	0	1	+100%
Total	**13**	**7**	**-46%**

Finally, when narrowing in on speed humps alone, the most notable finding is that severe injuries were eliminated entirely whereas visible injuries dropped by 75%. Complaints of pain reduced by 14% but this finding makes sense considering that there were fewer injuries in the "after" period regardless.

Table 8. Injury severity one year before and after speed humps introduced.

Injury Severity	One Year Before	One Year After	% Change
Fatal	0	0	0%
Severe injury	2	0	-100%
Visible injury	4	1	-75%
Complaint of pain	7	6	-14%
Total	**13**	**7**	**-46%**

Analysis

COVID-19 impacted travel behaviors in 2020, which is likely reflected in the results of this report. People began to drive and travel less (Block, 2020), up to 60% of businesses were shuttered permanently (Sundaram, 2020) and governments closed their doors to non-essential needs (State of California, 2020). Los Angeles County saw a reduction of 30% in vehicle miles traveled between December 2019 and March 2020; however, this reduction in VMT was not proportional in terms of incidents. Instead, Los Angeles saw the same number of fatal crashes in the year 2020 as it did in 2019. Vehicle speeds increased as there were fewer cars on the road. The LAist called it a "pandemic of speeding" which is apt for the disturbing trend of dangerous driving witnessed during the pandemic (Fonseca, 2021). As of writing this report, the pandemic is still on-going. This large caveat must be made in advance of considering the following analysis, findings are not an accurate representation of traffic during pre- or post-pandemic times.

The data suggests that that all interventions were successful in reducing the overall severity and total number of collisions on sampled roadways. Although performing paired sample t-tests only resulted in speed humps being statistically significant, it is worth noting that all interventions except bike lanes reduced the average speed of vehicles on sampled roadways (Figure 11). The lack of reduction for bike lanes could be a function of increased bicycling along these corridors and therefore there may be an aggregate reduction.

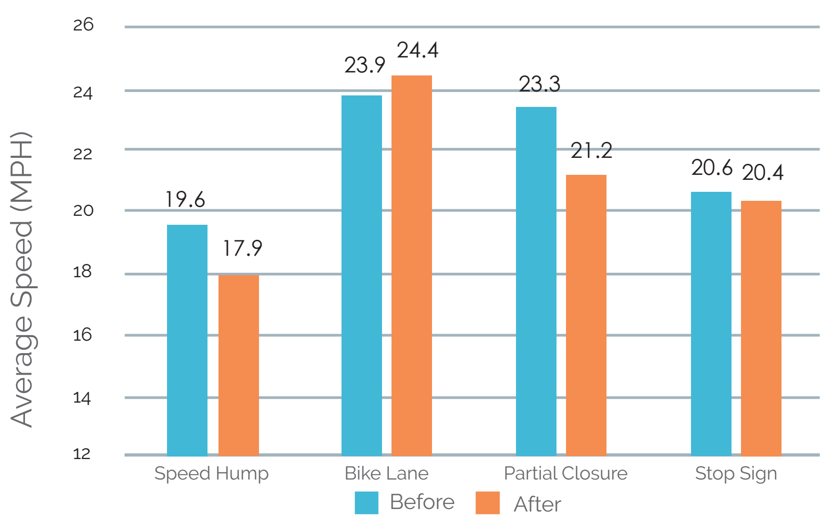

Figure 11. Average traffic speed in MPH one year before and after interventions.

In summary, the results of this study reveal that:

1. **The severity and number of collisions reduced as a result of introducing all measures, including speed humps, road diets/bike lanes, partial closures and stop signs.** There was a 38% reduction in overall incidents in the year after 2018 interventions were installed. The severity of incidents went down as well, shown in the 75% reduction in severe/fatal incidents. Although the impetus to install a traffic calming measure is not typically a collision, it fulfills the overarching goal of enhancing safety.

2. **Speed humps are the most cost-effective and proven method of traffic calming included in this analysis.** The results align with previous research that speed humps have a significant impact on the speed of vehicles (Ewing, 2001). In the sample, there was a significant difference between the traffic counts before and after they were introduced. The average difference between the "before" and "after" period was between -346 vehicles and -203 vehicles. On average, vehicle speeds reduced between -0.95MPH and -2.08MPH. Even in the pandemic, figures of both speed and volume were notable after speed humps were introduced. A little over half of the segment samples in this study (9 of17) had speed humps introduced in 2019. The "after" period of the 2019 speed humps would include moments in time when people were driving less anyway. Further, the average national cost of speed hump installation ranges between $2,000 and $5,000, making it one of the lowest cost alternatives for traffic calming (FHWA, n.d.).

3. **Design measures that make a road less viable for thoroughfare (i.e. partial closures, peak hour turn restrictions) can reduce cut-through traffic volume and related collisions.** In the case of Baxter Street, roadway reconfiguration into a one-way street and limiting evening peak-hour turns addressed resident concerns about navigation apps directing unfamiliar drivers into the neighborhood. After the safety improvements, Baxter Street saw a vehicular volume decrease of roughly 40% and speed decrease (-20% to -30%) along tested segments. The absolute change in collisions decreased from 39.26 collisions per million VMT to 0.00 collisions per million VMT.

When a road is made less viable for through traffic, there is a related improvement in safety because less cars are likely to be routed to it. The mechanism associated with reduced volume and related collisions is the overall reduction in points of conflict (Bellefleur & Gagnon, 2012). This finding is valuable for other steep streets but given the substantial decrease could be explored for other residential corridors experiencing cut-through traffic.

Limitations

Data and Sample Size

This report was merely a starting point to investigate the efficacy of traffic calming measures. For statistical analysis, the sample size used for this report was smaller than what is required to assess the significance of interventions on Los Angeles roadways. For traffic count/speed, I was limited to data available in 2018 and 2019 to allow for before and after analysis on Streetlight, which excluded many potential samples. For collision analysis, I excluded all 2019 samples because SWITRS did not have 2020 data available. The data for 2019 may not be "final" or complete because it takes over a year for the California Highway Patrol to input SWITRS collision data, TIMS mapping shows lower collision numbers until the numbers are finalized. Limited data and time did not permit exploring the full menu of traffic calming options that exist but this project focuses on commonly found interventions.

COVID-19 Pandemic

Included in this study is a time period affected by COVID-19. The pandemic is an anomaly in recent time that changes the outcome of traffic metrics, and the data I used for this report are no exception. Los Angeles saw a reduction of 30% in VMT between December 2019 and March 2020 while documented speeds and severe collisions increased (ITE, 2020). Land use changes during the pandemic may have increased or decreased traffic in different areas of the city. Drivers may have felt more comfortable to drive at a faster speed than they normally would if the streets were filled with more cars. However, COVID could also be viewed as an opportunity to demonstrate how successful some measures are despite increased collisions during the pandemic. As of writing this, the pandemic is still on-going and a variable worth noting.

Conclusion

When roadways are designed to be less about thoroughfare and more about livability, traffic cannot expand into all available space when people are enjoying public space. The growing concern about cut-through traffic in Los Angeles has brought to the forefront a troubling weak point related to transportation planning in the city. The city has ambitious plans to improve safety but does not appear equipped to systematically cut traffic crashes based on its size and limited transportation budget. This report was written in response to residents across Los Angeles that are plagued by cut-through traffic in their neighborhoods, causing serious safety concerns. The literature found that traffic calming originated with two separate, but related purposes: to reclaim the road for non-motorized users and to enhance overall safety. Traffic calming has been found to be effective in reducing vehicular speeds but inconclusive when regulating traffic volumes. The magnitude of safety benefits are a function of the mechanisms employed by traffic calming for increased roadway safety: increased driver alertness, speed homogenization, reduced points of conflict and improved pedestrian visibility. Additional benefits are increased property values, social benefits and even improved business activity.

This report addressed the central question of whether common, low-cost interventions like speed humps or partial closures can effectively address traffic concerns on a limited budget. I found that low-cost alternatives are highly successful in reducing the severity of collisions and improving overall safety in the community. While not as uniformly effective, bike lanes, partial closures and stop signs address issues of speed and traffic volumes.The partial closure along Baxter Street in particularis exemplary of how the use of mere signage and striping can greatly reduce cut-through traffic and related incidents by re-routing drivers to stay on bigger streets designed to carry higher volumes.

I found that speed humps were the most cost effective and successful measure of reducing average vehicular speed. The results suggested that the speed humps were significantly effective in reducing the speed humps of vehicles across sampled segments, even when you remove the possibility of COVID-19 altering how drivers behave and skewing the data.

On average, speed humps reduced speeds by 8% and traffic count by 9%. They were also associated with a 46% drop in total injuries and complete elimination of severe or fatal injuries. The cost to install one block of speed humps is typically between $4,000 and $7,000 which is substantially lower than other measures like a chicane or traffic circle, which can cost upward of $20,000. While all these traffic calming devices may prove to be effective, speed humps are far more scalable. Put differently, for the cost of one traffic circle, the City could install at least 4 blocks of speed humps.

Recommendations

The interventions covered in this report are scalable and can be implemented systematically throughout the City of Los Angeles. Equally important to the effectiveness of an intervention is the ability to distribute the benefits. For this reason, I make the following recommendations to make speed humps a top priority for traffic calming in the City:

1. **Eliminate the petition process altogether. At minimum, lower the threshold to apply and have a different process for streets with higher residential density or where residences are not easily accessible due to the presence of apartment complexes.** The city could pilot eliminating the petitioning process in low-income communities where the process poses a disproportionate barrier. My analysis has shown that speed humps are extremely effective and there is no need to have artificial barriers in place. While speed humps are the most cost-effective and proven method of traffic calming, they are also the most time-consuming measure to apply for in Los Angeles. For instance, in areas where the residential composition is denser than others (i.e. multi-family homes, apartment buildings), LADOT could consider lowering the required number of signatures from 66% to 51% of neighbors. Garnering signatures from a larger number of residents is more time-consuming when compared to a street with entirely single-family homes. Lowering the barriers to the petitioning process will enable more residents to apply.

2. **Increase the traffic calming budget to allow for more speed humps and other measures to be installed throughout the City.**

Budgetary limitations are the primary reason why the program was halted during COVID-19 (LADOT, n.d.). Speed humps continue to be limited to selected neighborhoods after careful consideration, but the City's budget should allow for an increase in the capacity of the program so that it is not limited to an oversubscribed quarterly petition process. More generally, this analysis showed that the common traffic calming treatments that LADOT employs are effective. Increasing the Department's budget to implement traffic calming measures at-large will help the Department realize it's noble goal of eliminating traffic deaths.

3. **Create a user guide (in English and Spanish) for residents to be better informed of what tools are available to calm traffic in their neighborhood.** LADOT already has pamphlets on their website that summarize the petitioning process and the advantages of speed humps; however, even if the petitioning process is eliminated, it is important that residents know what pathways are available for calming traffic in their community. To expand and build on existing informational resources, a user guide will inform LA residents about the benefits of speed humps and other interventions with digestible visual graphics and photos.

4. **Replace or complement request-based traffic calming with a quantitative prioritization process. Establish priority areas throughout Los Angeles to proactively identify key places like schools and low income areas, in consultation with residents when needed.** LADOT relies on requests and this inherently favors the more privileged and informed, not necessarily those who are most in need. As long as transportation funding remains limited, it is important to maximize the effectiveness of measures that get installed. Studies have shown that low-income neighborhoods are where collisions are most concentrated because they are closer to freeways and other sources of increased cut-through traffic (Hooverstein, 2019). Schools will benefit from speed humps to ensure that cars drive slowly around young people. LADOT should identify low-income areas and evaluate whether speed humps make sense in each context. After establishing these priority areas, the department should consult with local neighborhood governance boards to liaise with residents about potential safety improvements that can be made, whether it be speed humps or not. This way, the system is proactive rather than being primarily application-driven.

5. **Perform an in-depth analysis of before-and-after interventions were introduced to better understand the extent and effectiveness of various measures throughout the City.** This report was a starting point for the Department of Transportation to evaluate a small sample of measures that were introduced in recent years. Future studies should address the long-term impacts of traffic calming measures beyond the last few years, factoring in the effects of different built environments on the effectiveness of all interventions.

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Appendices

Appendix A: T-Tests

Speed Humps: Speed

t-Test: Paired Two Sample for Means

	Before	*After*
Mean	19.5223529	18
Variance	23.1160566	11.55695
Observations	17	17
Pearson Correlation	0.89601625	
Hypothesized Mean Difference	0	
df	16	
t Stat	2.70545908	
P(T<=t) one-tail	0.0077983	
t Critical one-tail	1.74588368	
P(T<=t) two-tail	0.01559661	
t Critical two-tail	2.1199053	

Mean differences	-1.522352941
Stand. Dev. of difference	2.320057999
Stand. Error of difference	0.562696717
T alpha half 95% CI	2.119905299
Lower Confidence Level	-2.085049658
Upper Confidence Level	-0.959656224

Speed Humps: Traffic Count

t-Test: Paired Two Sample for Means

	Before	*After*
Mean	2468.29412	2194.35294
Variance	1356645.6	881404.368
Observations	17	17
Pearson Correlation	0.98361879	
Hypothesized Mean Difference	0	
df	16	
t Stat	3.83228373	
P(T<=t) one-tail	0.0007346	
t Critical one-tail	1.74588368	
P(T<=t) two-tail	0.0014692	
t Critical two-tail	2.1199053	

Mean differences	-273.9411765
Stand. Dev. of difference	294.7298489
Stand. Error of difference	71.48248812
T alpha half 95% CI	2.119905299
Lower Confidence Level	-345.4236646
Upper Confidence Level	-202.4586884

Speed Humps: Speed Pre-2018

t-Test: Paired Two Sample for Means

	Before	*After*
Mean	19.07875	16.89375
Variance	40.70104107	15.9545982
Observations	8	8
Pearson Correlation	0.981261435	
Hypothesized Mean Difference	0	
df	7	
t Stat	2.397405366	
P(T<=t) one-tail	0.023823726	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.047647452	
t Critical two-tail	2.364624252	

Speed Humps: Traffic Count Pre-2018

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	1931.375	1847.75
Variance	436447.9821	359227.357
Observations	8	8
Pearson Correlation	0.955412163	
Hypothesized Mean Difference	0	
df	7	
t Stat	1.196690245	
P(T<=t) one-tail	0.135190037	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.270380075	
t Critical two-tail	2.364624252	

Figure A-1. Paired sample t-tests of speed humps.

Bike Lanes: Speed

	Before	After
Mean	25.4211111	25.8133333
Variance	30.5440111	30.2883
Observations	9	9
Pearson Correlation	0.98107885	
Hypothesized Mean Difference	0	
df	8	
t Stat	-1.0965113	
P(T<=t) one-tail	0.152381	
t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.30476199	
t Critical two-tail	2.30600414	
Mean differences	0.39222222	
Stand. Dev. of difference	1.07310039	
Stand. Error of difference	0.35770013	
T alpha half 95% CI	2.30600414	
Lower Confidence Level	0.03452209	
Upper Confidence Level	0.74992235	

Bike Lanes: Traffic Count

t-Test: Paired Two Sample for Means

	Before	After
Mean	16476.6667	15779.6667
Variance	104528753	90472609
Observations	9	9
Pearson Correlation	0.9976807	
Hypothesized Mean Difference	0	
df	8	
t Stat	2.13595515	
P(T<=t) one-tail	0.03259286	
t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.06518572	
t Critical two-tail	2.30600414	
Mean differences	-697	
Stand. Dev. of difference	978.95314	
Stand. Error of difference	326.317713	
T alpha half 95% CI	2.30600414	
Lower Confidence Level	-1023.3177	
Upper Confidence Level	-370.68229	

Figure A-2. Paired sample t-tests of bike lanes.

Partial Closures: Speed

t-Test: Paired Two Sample for Means

	Before	After
Mean	23.34	21.2
Variance	14.41566667	46.6182
Observations	4	4
Pearson Correlation	0.923082086	
Hypothesized Mean Difference	0	
df	3	
t Stat	1.179163292	
P(T<=t) one-tail	0.161667085	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.323334171	
t Critical two-tail	3.182446305	
Mean differences	-2.14	
Stand. Dev. of difference	3.629692365	
Stand. Error of difference	1.814846183	
T alpha half 95% CI	3.182446305	
Lower Confidence Level	-3.95484618	
Upper Confidence Level	-0.32515382	

Partial Closures: Traffic Count

t-Test: Paired Two Sample for Means

	Before	After
Mean	9381.5	7717.25
Variance	195622610	143059357
Observations	4	4
Pearson Correlation	0.99974661	
Hypothesized Mean Difference	0	
df	3	
t Stat	1.62636315	
P(T<=t) one-tail	0.10117373	
t Critical one-tail	2.35336343	
P(T<=t) two-tail	0.20234746	
t Critical two-tail	3.18244631	
Mean differences	-1664.25	
Stand. Dev. of difference	2046.590885	
Stand. Error of difference	1023.295442	
T alpha half 95% CI	3.182446305	
Lower Confidence Level	-2687.54544	
Upper Confidence Level	-640.954558	

Figure A-3. Paired sample t-tests of partial closures.

Stop Signs: Speed

t-Test: Paired Two Sample for Means

	Before	*After*
Mean	20.60625	20.43
Variance	45.19936964	43.7420571
Observations	8	8
Pearson Correlation	0.988497133	
Hypothesized Mean Difference	0	
df	7	
t Stat	0.490036352	
P(T<=t) one-tail	0.319546261	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.639092521	
t Critical two-tail	2.364624252	

Mean differences	-0.17625
Stand. Dev. of difference	1.01729245
Stand. Error of difference	0.359667195
T alpha half 95% CI	2.364624252
Lower Confidence Level	0.183417195
Upper Confidence Level	-0.535917195

Stop Signs: Traffic Count

t-Test: Paired Two Sample for Means

	Before	*After*
Mean	7846.625	7050.125
Variance	49709360.3	41570310.7
Observations	8	8
Pearson Correlation	0.9924886	
Hypothesized Mean Difference	0	
df	7	
t Stat	2.20222742	
P(T<=t) one-tail	0.03176091	
t Critical one-tail	1.89457861	
P(T<=t) two-tail	0.06352182	
t Critical two-tail	2.36462425	

Mean differences	-796.5
Stand. Dev. of difference	1022.983452
Stand. Error of difference	361.6792679
T alpha half 95% CI	2.364624252
Lower Confidence Level	-1158.179268
Upper Confidence Level	-434.8207321

Figure A-4. Paired sample t-tests of stop signs.

Appendix B: Built Environment

Loma Vista Pl Los Angeles, CA 90039

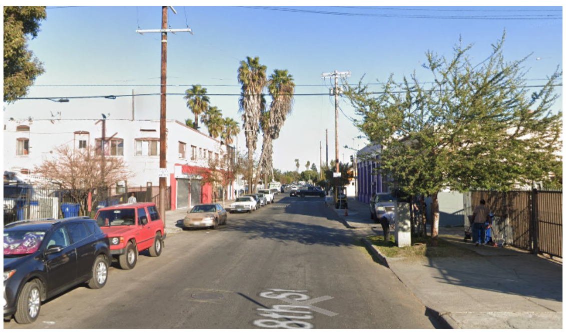
Palm Grove Ave Los Angeles, CA 90016

Westmoreland Bl, Los Angeles, CA

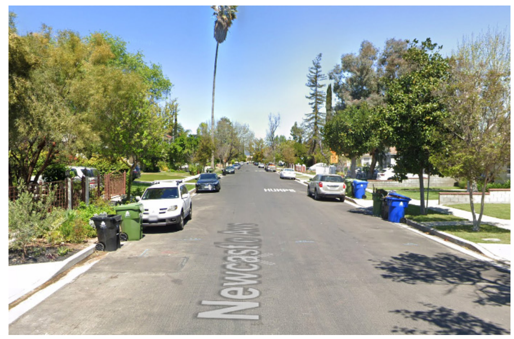
E 46th St., Los Angeles, CA 90011

W. 58th Street, Los Angeles 90037

E 76th Place, Los Angeles 90001



W 48th St Los Angeles, CA 90037



Newcastle Av, Encino, CA 91316

Orange Street, Los Angeles, CA 90048

Pickford St, Los Angeles, CA 90035

San Pascual Ave, Los Angeles, CA 90042

W 84th St, Los Angeles CA 90044

Hatteras St., Sherman Oaks, CA 91411

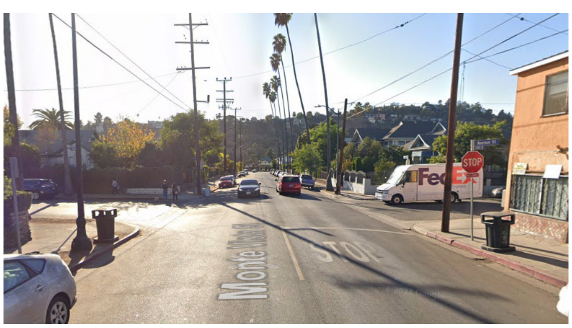
W 59th St., Los Angeles, CA 90044

N Windsor Blvd Los Angeles, CA 90004

Corteen Place, Los Angeles, CA 91607

Wells Drive, Los Angeles, CA 91356

Fletcher Dr & Weldon Ave, Los Angeles CA 90065



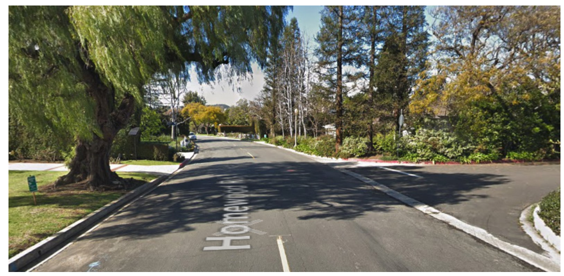
Monte Vista St & N Avenue 51, Los Angeles CA 90042

Effie St & Sanborn Ave, Los Angeles CA 90029

S Avenue 60 & Echo St, Los Angeles CA 90042

N Bronson Ave & Carlos Ave, Los Angeles CA 90028

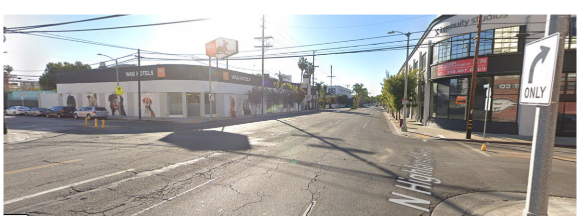
S Lucerne Blvd & W 10th St, Los Angeles CA 90019



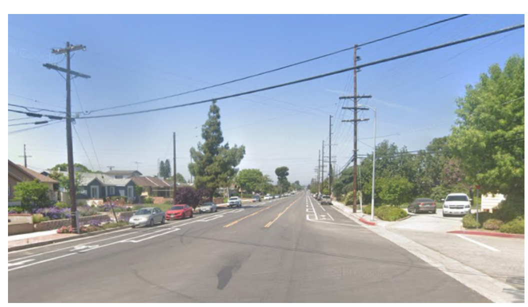
Homewood Rd/ N. Bonhill Rd, Los Angeles CA 90049

W 24th St & Arlington Ave, Los Angeles CA 90018

W 24th St & Arlington Ave, Los Angeles CA 90018



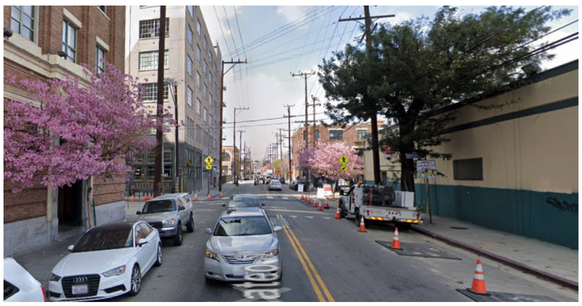
Romaine St & N Highland Ave, Los Angeles CA 90038



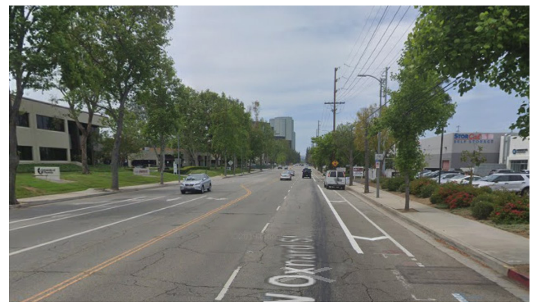
Chatsworth St, Los Angeles CA 91345

Hoover St, Los Angeles CA 90020

E Cesar Chavez Ave, Los Angeles CA 90063

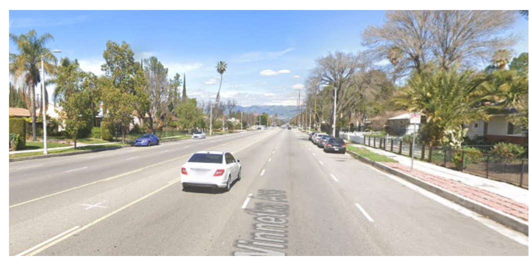


Mateo St, Los Angeles CA 90013



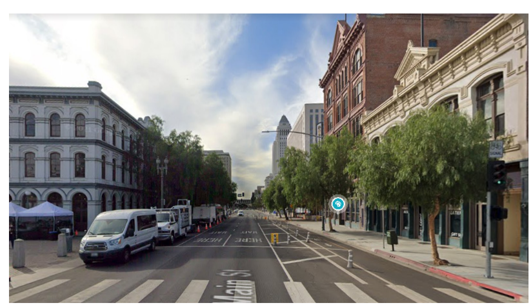
W Oxnard St, Los Angeles CA 91367

W 19th St, Los Angeles 90732



Winnetka Ave, Los Angeles CA 91306

Alhambra Ave, Los Angeles CA 90032



N Main St, Los Angeles CA 90012

Appendix C: Traffic Speed, Counts and Collisions

Intervention	#	# SH	Zip Code	Primary Street	Limit 1	Limit 2	Intersection/ Location/ Bike Lane Type	Segment Length (mi)	Posted Speed Limit (MPH)	CD	Install Date (mm/dd/yyyy)	Cost ($)	Traffic Count Before
Speed Hump	1	2	90039	Allesandro Wy	Lake View Ave	Oak St	2225 Loma Vista Pl Los Angeles, CA 90039	0.19	25	13	6/25/2018	8673	2460
Speed Hump	2	3	90016	Palm Grove Ave	Adams Blvd	Hickory St	2717 S Palm Grove Ave Los Angeles, CA 90016	0.21	25	10	8/30/2018	11946	1425
Speed Hump	3	3	90006	Westmoreland Blvd	Washington Blvd	Venice Blvd	1702 Westmoreland Bl, Los Angeles, CA	0.25	25	10	9/26/2018	16266	1738
Speed Hump	4	3	90011	46th Street	Central	McKinley	1041 E 46th St., Los Angeles, CA 90011	0.25	25	9	11/22/2019	12079	1990
Speed Hump	5	3	90037	58th St	Hoover	Vermont	808 W. 58th Street, Los Angeles 90037	0.25	25	9	12/10/2019	17121	2952
Speed Hump	6	2	90001	76th Place	Wadsworth	Central Ave	76th Pl (Wadsworth Av and Central Av)	0.13	25	9	1/29/2019	7809	1855
Speed Hump	7	2	90037	48th St	Vermont Av	Kansas Av	1031 W 48th St Los Angeles, CA 90037	0.26	25	9	9/24/2019	8097	2864
Speed Hump	8	3	91316	Newcastle Av	Santa Rita St	Palora St	5132 Newcastle Av, Encino, CA 91316	0.24	25	5	3/27/2018	14538	1259
Speed Hump	9	3	90048	Orange St	Crescent Heights	Fairfax	6227 Orange Street, Los Angeles, CA 90048	0.21	25	5	4/4/2018	14842	2992
Speed Hump	10	2	90035	Pickford St	Robertson Blvd	Livonia	8839 Pickford St, Los Angeles, CA	0.12	25	5	12/19/2018	7809	2092
Speed Hump	11	5	90042	San Pascual	York Blvd	Comet St	815 San Pascual Ave, Los Angeles, CA 90042	0.65	30	14	9/25/2019	Not available	6026
Speed Hump	12	3	90044	84th Street	Figueroa	Hoover	613 W 84th St, LA CA 90044	0.25	25	8	11/4/2019	Not available	1821
Speed Hump	13	4	91411	Hatteras st	Kester	Columbus	15001 Hatteras St Sherman Oaks, CA 91411	0.38	30	4	9/16/2019	22,320	3331
Speed Hump	14	2	90044	W 59th Street	Normandie Av	Raymond Av	1316 West 59th Street Los Angeles CA 90044	0.25	25	9	6/20/2018	8097	1107
Speed Hump	15	3	90004	N Windsor Blvd	Clinton St	Beverly Blvd	539 N Windsor Blvd Los Angeles, 90004	0.38	25	4	12/18/2018	14,970	2378
Speed Hump	16	2	91607	Corteen Place	Magnolia Blvd	Chandler Blvd	12345 W Magnolia Blvd, Los Angeles, 91607	0.25	25	2	11/8/2019	14,961	2042
Speed Hump	17	2	91356	Wells Drive	Shirley Ave	Calvin Ave	19417 Wells Dr, Tarzana, CA 91356	0.15	25	3	11/12/2019	11,145	3629
Stop Sign	1		90065	Fletcher Dr*	Portner St	Andrita St	Weldon Ave	0.20	30	13	12/13/2019	N/A	18393
Stop Sign	2		90042	Monte Vista St	Avenue 50	Avenue 52	Avenue 51	0.16	25	1	7/22/2019	N/A	8794
Stop Sign	3		90029	Effie St*	Myra Ave	Hyperion Ave	Sanbourn Ave	0.15	25	13	6/12/2018	N/A	2081
Stop Sign	4		90042	S Avenue 60	Benner St	N Figuera St	Echo St	0.24	30	14	3/7/2019	N/A	17528
Stop Sign	5		90068	N Bronson Avenue*	Franklin Avenue	Hollywood Boulevard	Carlos Ave	0.22	25	13	10/28/2019	N/A	9857
Stop Sign	6		90019	S Lucerne Blvd/10th St	Olympic Blvd	9th St	Lucerne Blvd/W 10th St, All Way	0.18	25		8/1/2019	N/A	3599
Stop Sign	7		90049	Homewood Rd/ N. Bonhill Rd	Bonhill Rd	Tuallitan Rd	Homewood/BonHill, All way	0.25	25	11	k of 09/12/2019	N/A	1133
Stop Sign	8		90035	Alcott St/Glenville Dr	Oakhurst	Beverly Dr	Alcott St/Glenville Dr, all way	0.25	25		5/30/2019	N/A	1388
Closure/Partial	1		90026	Baxter Street	Lake Shore Avenue	Alvarado Street	Lake Shore Avenue	0.06	25	13	5/22/2018	N/A	2326
Closure/Partial	2		90026	Baxter Street	Lake Shore Avenue	Lemonye Street	Lake Shore Avenue	0.06	25	13	5/22/2018	N/A	1679
Closure/Partial	3		90065	North Figueroa Street ("little Figueroa")	Marmion Way	Avenue 37	Marmion Way	0.09	25	1	10/25/2019	N/A	30341
Closure/Partial	5		90038	Romaine Street	Mansfield Ave	Las Palmas Ave	N Highland Ave	0.23	25	13	7/11/2019	N/A	3180
Bike Lane	1		91345	Chatsworth St	Chatsworth Dr	Arleta Ave	Road diet	0.67		7	10/31/2018	N/A	7836
Bike Lane	2		90037	Hoover St	Martin Luther King Jr Dr	W Vernon Ave	Road diet, pedestrian island(s)	0.49		9	3/6/2019	N/A	11196
Bike Lane	3		90063	E Cesar Chavez Ave	N Lorena Ave	Evergreen Ave	Lane narrowing	0.46	30	14	5/10/2019	N/A	36519
Bike Lane	4		90013	Mateo St	Santa Fe Ave	6th St	Lane narrowing and partial parking removal	0.25		14	2/20/2019	N/A	11150
Bike Lane	5		91367	Oxnard St	De Soto Ave	Topanga Canyon Bl	Lane narrowing to upgrade existing bike lane to buffered bike lane	0.83		3	4/22/2019	N/A	9135
Bike Lane	6		90732	19th St	Walker Ave	Western Ave	Road diet; removing center turn lane	0.43	30	15	9/9/2019	N/A	6832
Bike Lane	8		91306	Winnetka Ave	Victory Bl	Vanowen St	Road diet; removed peak hour lane	0.53	40	3	5/30/2019	N/A	28657
Bike Lane	9		90032	Alhambra Avenue	Druid St	Lowell Ave	road diet	1.10	35	14	6/28/2018	N/A	18862
Bike Lane	10		90012	N Main Street	E Arcadia St	Cesar Chavez Ave	Road diet, upgrading buffered bike lane to protected bike lane	0.18		14	7/9/2019	N/A	18103

Intervention	#	# SH	Zip Code	Primary Street	Traffic Count After	Raw Change	% Change	Speed Before	Speed After	Raw Change	% Change	2014-2018 Census Tract Median Income (ACS)
Speed Hump	1	2	90039	Allesandro Wy	1963	-497	-20.20%	33.75	25.25	-8.50	-25.19%	94,710
Speed Hump	2	3	90016	Palm Grove Ave	1358	-67	-4.70%	15.00	14.00	-1.00	-6.67%	50,676
Speed Hump	3	3	90006	Westmoreland Blvd	1842	104	5.98%	18.00	16.50	-1.50	-8.33%	41,385
Speed Hump	4	3	90011	46th Street	1675	-315	-15.83%	17.25	16.25	-1.00	-5.80%	42,308
Speed Hump	5	3	90037	58th St	2584	-368	-12.47%	16.00	15.75	-0.25	-1.56%	37,067
Speed Hump	6	2	90001	76th Place	1792	-63	-3.40%	23.00	17.00	-6.00	-26.09%	40,388
Speed Hump	7	2	90037	48th St	2472	-392	-13.69%	18.33	19.00	0.67	3.66%	34,273
Speed Hump	8	3	91316	Newcastle Av	1429	170	13.50%	21.00	19.00	-2.00	-9.52%	69,048
Speed Hump	9	3	90048	Orange St	2890	-102	-3.41%	19.38	18.40	-0.98	-5.06%	105,522
Speed Hump	10	2	90035	Pickford St	2012	-80	-3.82%	16.00	14.50	-1.50	-9.38%	93,083
Speed Hump	11	5	90042	San Pascual	5136	-890	-14.77%	21.79	21.07	-0.72	-3.30%	59,076
Speed Hump	12	3	90044	84th Street	1517	-304	-16.69%	20.00	17.67	-2.33	-11.65%	33,375
Speed Hump	13	4	91411	Hatteras st	2689	-642	-19.27%	19.71	18.71	-1.00	-5.07%	75,000
Speed Hump	14	2	90044	W 59th Street	977	-130	-11.74%	14.00	13.00	-1.00	-7.14%	45,147
Speed Hump	15	3	90004	N Windsor Blvd	2311	-67	-2.82%	15.50	15.50	0.00	0.00%	74,118
Speed Hump	16	2	91607	Corteen Place	1793	-249	-12.19%	18.50	18.00	-0.50	-2.70%	56,223
Speed Hump	17	2	91356	Wells Drive	2864	-765	-21.08%	25.67	25.17	-0.50	-1.95%	
Stop Sign	1		90065	Fletcher Dr*	15344	-3049	-16.58%	32.00	30.00	-2	-6.25%	45,769
Stop Sign	2		90042	Monte Vista St	7936	-858	-9.76%	21.67	22.00	0.33	1.52%	44,276
Stop Sign	3		90029	Effie St*	1840	-241	-11.58%	13.50	13.00	-0.50	-3.70%	89,668
Stop Sign	4		90042	S Avenue 60	17417	-111	-0.63%	28.57	29.00	0.43	1.51%	
Stop Sign	5		90068	N Bronson Avenue*	8417	-1440	-14.61%	21.50	23.00	1.50	6.98%	
Stop Sign	6		90019	S Lucerne Blvd/10th St	3155	-444	-12.34%	16.00	16.00	0.00	0.00%	
Stop Sign	7		90049	Homewood Rd/ N. Bonhill Rd	998	-135	-11.92%	17.11	16.44	-0.67	-3.92%	
Stop Sign	8		90035	Alcott St/Glenville Dr	1294	-94	-6.77%	14.50	14.00	-0.50	-3.45%	
Closure/Partial	1		90026	Baxter Street	1446	-880	-37.83%	23.61	18.89	-4.72	-19.99%	
Closure/Partial	2		90026	Baxter Street	1006	-673	-40.08%	19.22	13.44	-5.78	-30.07%	
Closure/Partial	3		90065	North Figueroa Street ("little Figueroa")	25622	-4719	-15.55%	28.33	29.67	1.34	4.73%	
Closure/Partial	5		90038	Romaine Street	2795	-385	-12.11%	22.20	22.80	0.60	2.70%	
Bike Lane	1		91345	Chatsworth St	7900	64	0.82%	37.50	37.07	-0.43	-1.15%	
Bike Lane	2		90037	Hoover St	11447	251	2.24%	21.21	21.84	0.63	2.97%	
Bike Lane	3		90063	E Cesar Chavez Ave	34602	-1917	-5.25%	23.70	26.20	2.50	10.55%	
Bike Lane	4		90013	Mateo St	11099	-51	-0.46%	25.17	24.83	-0.34	-1.35%	
Bike Lane	5		91367	Oxnard St	9157	22	0.24%	22.21	23.12	0.91	4.10%	
Bike Lane	6		90732	19th St	6016	-816	-11.94%	24.11	23.67	-0.44	-1.82%	
Bike Lane	8		91306	Winnetka Ave	26613	-2,044	-7.13%	28.94	30.44	1.50	5.18%	
Bike Lane	9		90032	Alhambra Avenue	18936	74	0.39%	27.52	27.29	-0.23	-0.84%	
Bike Lane	10		90012	N Main Street	16247	-1,856	-10.25%	18.43	17.86	-0.57	-3.09%	

Intervention	Zip Code	Primary Street	Limit 1	Limit 2	Intersection/ Location/ Bike Lane Type	Installation Date	Segment Length (mi)
Speed Hump	90039	Allesandro Wy	Lake View Ave	Oak St	2225 Loma Vista Pl Los Angeles, CA 90039	6/25/2018	0.19
Speed Hump	90016	Palm Grove Ave	Adams Blvd	Hickory St	2717 S Palm Grove Ave Los Angeles, CA 90016	8/30/2018	0.21
Speed Hump	90006	Westmoreland Bl	Washington Blvd	Venice Blvd	1702 Westmoreland Bl, Los Angeles, CA	9/26/2018	0.25
Speed Hump	91316	Newcastle Av	Santa Rita St	Palora St	5132 Newcastle Av, Encino, CA 91316	3/27/2018	0.24
Speed Hump	90048	Orange St	Crescent Heights	Fairfax	6227 Orange Street, Los Angeles, CA 90048	4/4/2018	0.21
Speed Hump	90035	Pickford St	Robertson Blvd	Livonia	8839 Pickford St, Los Angeles, CA	12/19/2018	0.12
Speed Hump	90044	W 59th Street	Normandie Av	Raymond Av	1316 West 59th Street Los Angeles CA 90044	6/20/2018	0.25
Speed Hump	90004	N Windsor Blvd	Clinton St	Beverly Blvd	539 N Windsor Blvd Los Angeles, 90004	12/18/2018	0.38
Stop Sign	90029	Effie St*; 1163 Sa	Myra Ave	Hyperion Ave	Sanbourn Ave	6/12/2018	0.15
Closure/Partial	90026	Baxter Street; 20	Lake Shore Aven	Alvarado Street	Lake Shore Avenue	5/22/2018	0.06
Closure/Partial	90026	Baxter Street	Lake Shore Aven	Lemonye Street	Lake Shore Avenue	5/22/2018	0.06
Bike Lane	91345	Chatsworth St; 1	Chatsworth Dr	Arleta Ave	Road diet	10/31/2018	0.67
Bike Lane	90032	Alhambra Avenu	Druid St	Lowell Ave	road diet	6/28/2018	1.10

Intervention	Zip Code	Primary Street	ADT Before	ADT After	# Incidents Before	# Incidents After	Before Collision Type
Speed Hump	90039	Allesandro Wy	2460	1963	0	0	N/A
Speed Hump	90016	Palm Grove Ave	1425	1358	1	1	C: Rear End
Speed Hump	90006	Westmoreland Bl	1738	1842	3	1	1) D: Broadside 2) G: Veh/ped 3) E: Parked motor vehicle
Speed Hump	91316	Newcastle Av	1259	1429	0	0	N/A
Speed Hump	90048	Orange St	2992	2890	6	2	1) C: Rear End 2) G: Vehicle/pedestrian 3) Not stated 4) D: Broadside 5) D: Broadside 6) D: Broadside
Speed Hump	90035	Pickford St	2092	2012	1	0	G: Vehicle/pedestrian
Speed Hump	90044	W 59th Street	1107	977	2	1	1) D: Broadside 2) D: Broadside
Speed Hump	90004	N Windsor Blvd	2378	2311	0	2	N/A
Stop Sign	90029	Effie St*; 1163 Sa	2081	1840	5	2	1) B: Sideswipe 2) D: Broadside 3) D: Broadside 4) D: Broadside 5) D: Broadside
Closure/Partial	90026	Baxter Street; 20	2326	1446	2	0	1) C: Rear end 2) A: Head on
Closure/Partial	90026	Baxter Street	1679	1006	0	0	N/A
Bike Lane	91345	Chatsworth St; 1	7836	7900	4	5	1) H: Other (Bicycle) 2) F: Overturned 3) I: Fixed object 4) A: Head on
Bike Lane	90032	Alhambra Avenu	18862	18936	10	7	1) D: Broadside 2) G: Vehicle/pedestrian 3) D: Broadside (object) 4) B: Sideswipe (parked vehicle) 5) D: Broadside 6) D: Broadside 7) B: Sideswipe 8) C: Rear end 9) B: Sideswipe (parked vehicle) 10) C: Rear end

Intervention	Zip Code	Primary Street	Before Notes	After Collision Type	After Notes
Speed Hump	90039	Allesandro Wy	N/A	N/A	N/A
Speed Hump	90016	Palm Grove Ave	4: Injury (complaint of pain)	A: Head-on	4: Injury (complaint of pain)
Speed Hump	90006	Westmoreland Bl	1) 2: Injury (severe) 2) 4: Injury (complaint of pain) 3) 3: Injury (other visible)	D: Broadside	3: Injury (other visible)
Speed Hump	91316	Newcastle Av	N/A	N/A	N/A
Speed Hump	90048	Orange St	1) 4: Injury (Complaint of pain) 2) 3: Injury (Other visible) 3) 4: Injury (Complaint of pain) 4) 4: Injury (Complaint of pain) 5) 2: Injury (Severe) 6) 4: Injury (Complaint of pain)	1) D: Broadside 2) D: Broadside	1) 4: Injury (complaint of pain) 2) 4: Injury (complaint of pain)
Speed Hump	90035	Pickford St	3: Injury (Other visible)	N/A	N/A
Speed Hump	90044	W 59th Street	1) 3: Injury (other visible) 2) 4: Injury (complaint of pain)	D: Broadside	4: Injury (complaint of pain)
Speed Hump	90004	N Windsor Blvd	N/A	1) B: Sideswipe 2) C: Rear end	1) 4: Injury (complaint of pain) 2) 4: Injury (complaint of pain)
Stop Sign	90029	Effie St*; 1163 Sa	1) 4: Injury (complaint of pain) 2) 4: Injury (complaint of pain) 3) 4: Injury (complaint of pain) 4) 4: Injury (complaint of pain) 5) 4: Injury (complaint of pain)	1) D: Broadside 2) G: Vehicle/pedestrian	1) 4: Injury (complaint of pain) 2) 3: Injury (other visible)
Closure/Partial	90026	Baxter Street; 20	1) 4: Injury (complaint of pain) 2) 3: Injury (other visible)	N/A	N/A
Closure/Partial	90026	Baxter Street	N/A	N/A	N/A
Bike Lane	91345	Chatsworth St; 1	1) 3: Injury (other visible) 2) 3: Injury (other visible) 3) 2: Injury (severe) 4) 3: Injury (other visible)	1) I: Fixed object 2) C: Rear end 3) D: Broadside 4) Not stated (parked vehicle) 5) G: Vehicle/pedestrian (bicycle)	1) 2: Injury (severe) 2) 3: Injury (visible) 3) 4: Injury (complaint of pain) 4) 3: Injury (other visible) 5) 3: Injury (other visible)
Bike Lane	90032	Alhambra Avenu	1) 3:Injury (other visible) 2) 1: Fatal 3) 3: Injury (other visible) 4) 3: Injury (other visible) 5) 4: Injury (complaint of pain) 6) 3: Injury (other visible) 7) 3: Injury (other visible) 8) 4: Injury (complaint of pain) 9) 4: Injury (complaint of pain) 10) 4: Injury (complaint of pain)	1) C: Rear end 2) C: Rear end 3) D: Broadside 4) D: Broadside 5) H: Other (backing out) 6) C: Rear end 7) D: Broadside (parked vehicle)	1) 4: Injury (complaint of pain) 2) 4: Injury (complaint of pain) 3) 4: Injury (complaint of pain) 4) 4: Injury (complaint of pain) 5) 4: Injury (complaint of pain) 6) 4: Injury (complaint of pain) 7) 3: Injury (other visible)

Intervention	Zip Code	Primary Street	Before Links
Speed Hump	90039	Allesandro Wy	N/A
Speed Hump	90016	Palm Grove Ave	https://tims.berkeley.edu/tools/details/main.php?no=8628338
Speed Hump	90006	Westmoreland Bl	1) https://tims.berkeley.edu/tools/details/main.php?no=8719703 2) https://tims.berkeley.edu/tools/details/main.php?no=8585174 3) https://tims.berkeley.edu/tools/details/main.php?no=8555454
Speed Hump	91316	Newcastle Av	N/A
Speed Hump	90048	Orange St	1) https://tims.berkeley.edu/tools/details/main.php?no=8585332 2) https://tims.berkeley.edu/tools/details/main.php?no=8414918 3) https://tims.berkeley.edu/tools/details/main.php?no=8355612 4) https://tims.berkeley.edu/tools/details/main.php?no=8575709 5) https://tims.berkeley.edu/tools/details/main.php?no=8607125 6) https://tims.berkeley.edu/tools/details/main.php?no=8560814
Speed Hump	90035	Pickford St	https://tims.berkeley.edu/tools/details/main.php?no=8570714
Speed Hump	90044	W 59th Street	1) https://tims.berkeley.edu/tools/details/main.php?no=8435793 2) https://tims.berkeley.edu/tools/details/main.php?no=8470591
Speed Hump	90004	N Windsor Blvd	N/A
Stop Sign	90029	Effie St*; 1163 Sa	1) https://tims.berkeley.edu/tools/details/main.php?no=8531395 2) https://tims.berkeley.edu/tools/details/main.php?no=8430458 3) https://tims.berkeley.edu/tools/details/main.php?no=8504482 4) https://tims.berkeley.edu/tools/details/main.php?no=8616520 5) https://tims.berkeley.edu/tools/details/main.php?no=8637671
Closure/Partial	90026	Baxter Street; 20	1) https://tims.berkeley.edu/tools/details/main.php?no=8517976 2) https://tims.berkeley.edu/tools/details/main.php?no=8583687
Closure/Partial	90026	Baxter Street	N/A
Bike Lane	91345	Chatsworth St; 1	1) https://tims.berkeley.edu/tools/details/main.php?no=8507249 2) https://tims.berkeley.edu/tools/details/main.php?no=8677731 3) https://tims.berkeley.edu/tools/details/main.php?no=8515383 4) https://tims.berkeley.edu/tools/details/main.php?no=8728299
Bike Lane	90032	Alhambra Avenu	1) https://tims.berkeley.edu/tools/details/main.php?no=8481148 2) https://tims.berkeley.edu/tools/details/main.php?no=8465561 3) https://tims.berkeley.edu/tools/details/main.php?no=8440669 4) https://tims.berkeley.edu/tools/details/main.php?no=8617166 5) https://tims.berkeley.edu/tools/details/main.php?no=8485024 6) https://tims.berkeley.edu/tools/details/main.php?no=8654970 7) https://tims.berkeley.edu/tools/details/main.php?no=8617187 8) https://tims.berkeley.edu/tools/details/main.php?no=8621602 9) https://tims.berkeley.edu/tools/details/main.php?no=8565147 10) https://tims.berkeley.edu/tools/details/main.php?no=8605080

Intervention	Zip Code	Primary Street	After Links	CRate Before	C Rate After
Speed Hump	90039	Allesandro Wy	N/A	0.00	0.00
Speed Hump	90016	Palm Grove Ave	https://tims.berkeley.edu/tools/details/main.php?no=8843370	9.30	9.75
Speed Hump	90006	Westmoreland Bl	https://tims.berkeley.edu/tools/details/main.php?no=8960122	18.97	5.97
Speed Hump	91316	Newcastle Av	N/A	0.00	0.00
Speed Hump	90048	Orange St	1) https://tims.berkeley.edu/tools/details/main.php?no=8734249 2) https://tims.berkeley.edu/tools/details/main.php?no=8662385	25.72	8.87
Speed Hump	90035	Pickford St		10.84	0.00
Speed Hump	90044	W 59th Street	https://tims.berkeley.edu/tools/details/main.php?no=8689878	19.65	11.13
Speed Hump	90004	N Windsor Blvd	1) https://tims.berkeley.edu/tools/details/main.php?no=8890461 2) https://tims.berkeley.edu/tools/details/main.php?no=8794080	0.00	6.27
Stop Sign	90029	Effie St*; 1163 Sa	1) https://tims.berkeley.edu/tools/details/main.php?no=8786966 2) https://tims.berkeley.edu/tools/details/main.php?no=8807468	43.88	19.85
Closure/Partial	90026	Baxter Street; 20	N/A	39.26	0.00
Closure/Partial	90026	Baxter Street	N/A	0.00	0.00
Bike Lane	91345	Chatsworth St; 1	1) https://tims.berkeley.edu/tools/details/main.php?no=9052824 2) https://tims.berkeley.edu/tools/details/main.php?no=8765462 3) https://tims.berkeley.edu/tools/details/main.php?no=8827177 4) https://tims.berkeley.edu/tools/details/main.php?no=8919343 5) https://tims.berkeley.edu/tools/details/main.php?no=8816100	2.09	2.59
Bike Lane	90032	Alhambra Avenu	1) https://tims.berkeley.edu/tools/details/main.php?no=8685040 2) https://tims.berkeley.edu/tools/details/main.php?no=8810026 3) https://tims.berkeley.edu/tools/details/main.php?no=8681075 4) https://tims.berkeley.edu/tools/details/main.php?no=8772270 5) https://tims.berkeley.edu/tools/details/main.php?no=8821526 6) https://tims.berkeley.edu/tools/details/main.php?no=8821259 7) https://tims.berkeley.edu/tools/details/main.php?no=8898597	1.32	0.92